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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply of

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HELICAL SPRINGS.
WHEELS and AXLES.

Specifications and Forms of Tender may be obtained at this office on payment of the fee for the Specification, which payment will not be returned.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Helical Springs," or, as the case may be, not later than Eleven o'clock a.m., on Thursday, the 14th June, 1917.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall Avenue, E.C., London,
6th June, 1917. G 948

IN THE MATTER OF THE TRADING WITH THE ENEMY AMENDMENT ACT, 1916.

The PUBLIC TRUSTEE invites

Tenders for the Purchase of

the Whole or any part of 119,669 Shares of £5 each, fully paid, in SIEMENS BROTHERS & COMPANY, LIMITED, vested in him as Custodian by an Order made by the Board of Trade, in pursuance of Section 4 of the Trading with the Enemy Amendment Act, 1916, and dated 9th August, 1916.

The issued capital of the Company consists of 130,000 Shares of £5 each, fully paid.

The purchasers, who must be British-born subjects, will be required to make a sworn Declaration as to nationality and freedom from foreign control on a form to be obtained from the Offices of the Public Trustee.

The purchasers will also be required to satisfy the Public Trustee as to their financial and technical ability to carry on the business of the Company as efficiently as heretofore, or otherwise to the satisfaction of the Government.

A report upon the Company's operations and affairs has been prepared by the Company, in conjunction with the Company's Auditors (Messrs. PRICE, WATERHOUSE & Co.), and with Messrs. TURQUAND, YOUNGS & Co. Copies of this report can be obtained, subject as hereinafter mentioned, together with copies of Company's accounts up to the 31st December, 1915, on written application to the Public Trustee, Kingsway, W.C.

All applicants will be required to satisfy the Public Trustee as to any matter which he may think fit to investigate before copies of such Report or accounts will be supplied.

Intending Tenderers who desire to inspect the property of the Company, should apply to the Public Trustee for an authority to do so.

Tenders must be delivered, sealed, to the Public Trustee, Kingsway, W.C., on or before Thursday, the 12th July, 1917 (NOT 14TH JUNE, AS PREVIOUSLY ADVERTISED), at Twelve o'clock Noon, and marked on the envelope, "Tender, Siemens Shares."

The Public Trustee does not bind himself to accept any Tender, and reserves to himself all rights in connection therewith.

Forms of Tender can be obtained from the PUBLIC TRUSTEE.

Dated this 8th day of February, 1917. 5943
C. J. STEWART, Public Trustee,
Custodian for England and Wales.

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RECONSTRUCTION OF UNION PACIFIC RAILROAD BRIDGE AT OMAHA.

THE first single-track bridge over the Missouri River was commenced in 1869, and completed in 1872, at an approximate cost of 1,750,000 dols. Considerable historic interest is attached to this bridge, as it is one of the oldest crossings of the Missouri River, the new structure, with the exception of the piers, being the third to occupy the site. It is a notable fact that all three of these Union Pacific bridges across the Missouri River occupy identically the same location. The one completed in 1872 was the first bridge to span the Missouri River at any point, and its location marks the crossing used by explorers, travellers and home-seekers that have gone west over the overland route for almost fifty years.

This bridge consisted of 11 spans of trusses known as the post type, each 250 ft. in length, the approach on the east side being a solid embankment, and on the west side a cotton-wood trestle, which trestle was later filled. In 1877 the two easterly spans were wrecked by a cyclone and never rebuilt, the spans being replaced by timber trestles. The substructure of the bridge consisted of 11 iron cylinder piers, and one stone pier, at the extreme west end, all these piers being founded on bed-rock. Each iron pier consisted of two cylinders 8½ ft. in diameter, placed at 18½ ft. centres.

In 1887 this bridge was replaced by a double-track structure, built by George S. Morrison, under the direction of Virgil G. Bogue, then chief engineer of the Union Pacific. In this second structure the main river crossing consisted of four through truss spans of substantially the same length as in the old bridge, but staggered so as to be supported on new piers placed midway between the old ones. The river spans of this second bridge were double intersection pin-connected Whipple trusses, 246 ft. 2⅞ in. long, subdivided into 11 panels. In addition to carrying two tracks, a driveway on each side, 12 ft. 1 in. wide, was cantilevered outside the trusses. This driveway was subsequently removed. The piers under these spans were built according to conventional designs for ashlar masonry river piers. They were 8 ft. wide and 35 ft. long at the top, not including the cylindrical ends. The usual starlings were carried for some distance above high-water line. All the piers were founded on rock except the first one from the west end in the west approach.

The work for reconstructing the second bridge was commenced in May, 1916, and terminated in December, 1916, at an approximate cost of 1,000,000 dols. The new bridge consists of four through Pratt riveted chord spans, 246 ft. long; one through riveted span, 130 ft. long, and two through Pratt riveted spans, 120 ft. long; four deck-plate girders, 67 ft. long, and two deck-plate girders, 50 ft. long, for two tracks. The total length of bridge is 1,722 ft., which does not include approaches. The total weight of the new bridge is about 11,250,000 lb., as against 5,500,000 lb. in the old bridge replaced. The height of track above normal water in the Missouri River is about 70 ft. We give in Fig. 1 on Plate LVII, published with the present issue, a view showing the new bridge in position, while Fig. 2 on the same Plate, and Figs. 3, 4 and 5 on Plate LVIII, show stages in the process of replacement, with which we shall now proceed to deal.

The work consisted in replacing the entire superstructure with new and heavier steel, the piers supporting the four main river spans remaining in place. The approach spans have been supported with new concrete substructure. On account of the heavy traffic it was imperative that the plan adopted for erection should be the one which offered the least interference with the regular use of the structure. It was concluded that this would best be accomplished by erecting the new spans complete on falsework and timber pier extensions in a position parallel to the existing bridge on the down-stream side, and to provide timber pier extensions on the up-stream side of the structure, on to which the old spans could be shifted out of the way as the completed new spans were moved into position on the piers.

The four river spans were erected on temporary pile pier extensions to the south of the old masonry piers, and similar temporary pile pier extensions were arranged for on the north of the old masonry piers. The old spans which had to be replaced were raised and mounted on rollers, and then moved to the north on the temporary pile extensions. These timber extensions are shown in Fig. 1, Plate LVII, already referred to, and they will be seen still more clearly in Fig. 2 on the same Plate, the latter view showing the old spans shifted on to the corresponding temporary timber piers, leaving the stone piers ready to receive the new bridge.

The spans of the new bridge, after resting on temporary piers on the south, as shown in Fig. 2, were, as we have stated, rolled into permanent position on the masonry piers. The movement was accomplished by means of 2-in. ropes reeved through four-sheave blocks into eight-part lines. One block of each set was attached to a snubbing post at the up-stream end of the temporary piers and the other block was secured to the end of the span. One complete set of these tackles was provided for each end of each of the spans. In the case of the old superstructure the blocks were lashed to the ends of the bottom chords, while in the new spans they were secured to pins at the ends of the bearing grillages, as shown in Fig. 5, Plate LVIII. Fig. 4 on the same Plate shows one of the roller tracks. The 2-in. ropes from these tackles were run to hoisting engines standing on the new spans, one engine being provided for each pier, or five in all. This plan necessitated four tackles from each intermediate pier and two at each of the end piers, but as the old and new spans were not moved simultaneously it was necessary to handle only two lines on the intermediate hoisting engines at a time. The lines passed from the winch heads on the hoists to snatch blocks lashed to the portal bracing, thence down through the floor to other snatch blocks, and then out to the four sheave blocks at the ends of the piers. The engines were blocked up solidly from the track with struts to take up the reaction caused by the tension in the lines.

To ensure control of the spans during the movement, a four-part wire cable hold-back line was provided at each pier to connect the spans with a timber anchored to the down-stream end of each temporary pier. The line from this tackle, which was passed around the drum of the hoisting engine, was out-hauled while the movement was in progress, and insured a measure of control by the use of the brake on the drum. To overcome starting friction jacks were set up in horizontal or inclined positions against the ends of the spans to assist the hoisting engines to start the movement. As these jacks could not be set up readily a second time after the spans had moved some distance, it was necessary to start the spans by use of the hoisting engines alone, following any intermediate stop in the movement. This was accomplished without difficulty.

To ensure unity of action in the hoisting engines spread out over a distance of 1,000 ft. a carefully-planned system of signals was provided. A signalman with a red flag was stationed at each pier on the floor of the structure to be moved, with two men at the centre pier. A head signalman stood at the middle of the new structure in clear view of all the hoisting engines. Upon the striking of a gong all the signalmen raised their flags and the engines were started simultaneously. Bridgemen stationed on each pier observed the action of the rollers and bearings as the movement took place, and in case of any difficulty called to the signalman on the bridge floor overhead, who immediately dropped his flag. This signal was relayed to the centre of the bridge, where the head signalman stopped all the engines by lowering his flag.

The bridge was closed to traffic to make the change shortly after 11 a.m. on December 23, 1916. At 11.25 the movement of the old superstructure was started, and by 12 o'clock it was out on the falsework clear of the masonry piers. About twenty minutes' work was necessary to roll back the roller nests released from under the old span, change the ropes on the hoisting engines, &c. With these changes made, the new span should have been in place in another 30 minutes except for the unlooked-for failure of two of the hoisting engines because of foaming boiler water. After an ineffective effort to overcome this trouble the lines were shifted so that the two disabled hoists could be released, and the lines from the two end piers run to the winch heads on two locomotive cranes which were stationed at the ends of the bridge. This change consumed considerable time, but the new spans were moved to final position by 4 p.m. Owing to the difference in the floor thickness of the old and new spans, the track on the latter when moved into place was approximately 2 ft. higher than the track on the adjoining approach spans. This difference, which will be seen in Fig. 3 on Plate LVIII, was overcome partially by releasing the rollers and rails under the bearings of the outer ends of the two end spans, but principally by jacking up the adjoining ends of the approach spans. To reduce the delay to the traffic to a minimum, no change was made immediately in the intermediate bearings of the new superstructure, as the rolling equipment was of ample strength to carry the train loading in addition to the deadweight of the bridge. For the release of the rollers and rails the spans were raised and subsequently lowered by means of 500-ton hydraulic jacks working on jacking frames at each end of the bearing grillages.

Track crews were held in readiness to close up the tracks as soon as the bridge ends were brought to grade, and signalmen bonded the joints so that automatic signals were restored to operation immediately, the rails for the entire length of the new spans having been bonded complete in advance of the change. Traffic was restored at 9.39 p.m. Every detail of the movement was carried out as planned, and save for the unfortunate difficulty with the boiler water, the closing unquestionably would have been completed according to schedule.

The old spans are to be dismantled without the use of falsework by cantilevering from the new structure. The members will be removed by a traveller working from the top chords of the new bridge. After the removal of the floor system the up-stream trusses will be taken down while supported from the down-stream trusses and the new bridge. Then the down-stream trusses will be removed in a similar manner while supported from the up-stream trusses of the new structure. As the old spans are in good condition, they will be supplied with a new single-track floor system and will be used elsewhere as single-track spans of the same length as at present.

The bridge carries a very heavy traffic, there being an average of 300 train movements per day. In addition to the trains of the Union Pacific operating between Omaha and Council Bluffs, this bridge carries all passenger and goods trains between Omaha and points east on the Chicago and North-Western, the Chicago, Milwaukee and St. Paul, the Chicago, Rock Island and Pacific, the Wabash, the Chicago Great Western and several trains of the Chicago, Burlington and Quincy. There are also numerous shunting movements between Omaha, Council Bluffs and Union Pacific Transfer. The spans recently replaced were built for double track, but with the increasing weight of locomotives it became necessary some time ago to restrict operation over this bridge to a single track. The rapid increase in the volume of business made it necessary to arrange for new spans which would permit the use of unrestricted double-track operation across the structure.

The present reconstruction involved the complete renewal of the superstructure and the partial renewal of the substructure for the approaches. No change was necessary in the substructure for the river spans. The latter vary from 249 ft. 3 in. to 250 ft. 4 in., the total distance between end piers being about 1,000 ft. These spans have pin-connected curbed-chord Pratt trusses. The top chord and end ports are of typical box section, laced on the lower side. The bottom chords are made up to eye-bars in all panels, the trusses being pin-connected at all joints. Tracks are spaced 13 ft. centre to centre, with side clearances of 7 ft. 6 in. from the centre line of tracks. The vertical clearance is 24 ft. from the base of rail. The usual construction is followed in the design of the floor system, stringers being spaced 7 ft. centre to centre for each track. To accord with modern practice and loading the new floor is 2 ft. deeper than the old one, a difference which was necessarily made up entirely by raising the tracks across the bridge, as already explained.

The new approaches differ materially from those

CIRCULATING WATER CONDUIT FOR 15,000-KW. TURBO-ALTERNATOR AT LOTS-ROAD POWER STATION.

CONSTRUCTED BY JOHN COCHRANE AND SONS, LIMITED, LONDON; MESSRS. MERZ AND McLELLAN, CONSULTING ENGINEERS, LONDON AND NEWCASTLE.

(For Description, see opposite Page.)

Fig. 49.

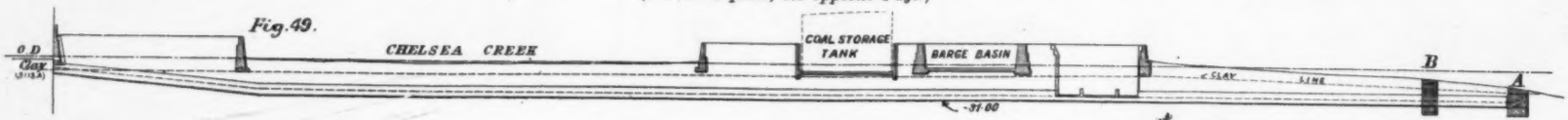


Fig. 50.

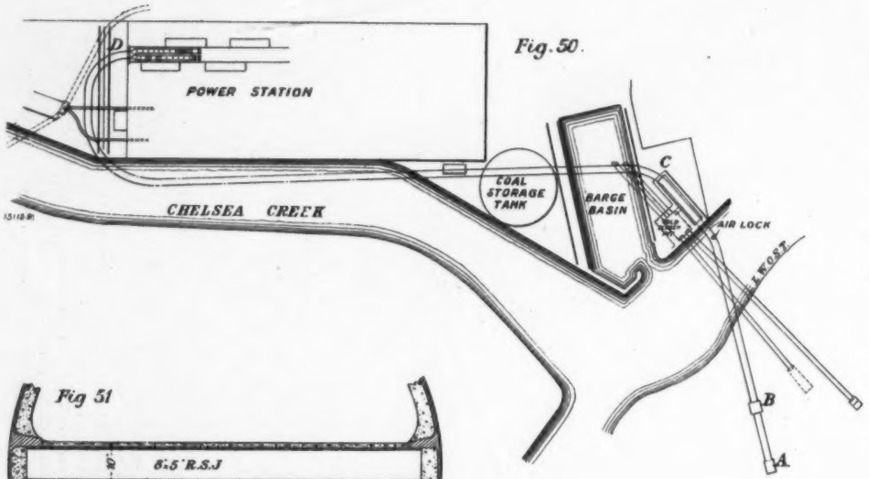


Fig. 53. SECTION Y.Y.

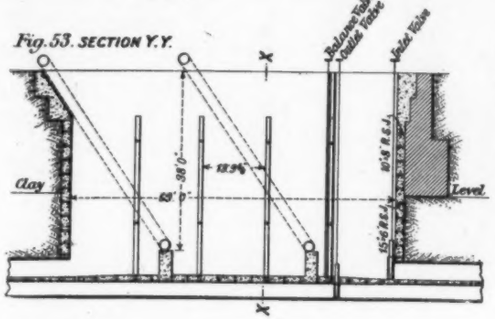


Fig. 54. SECTION X.X

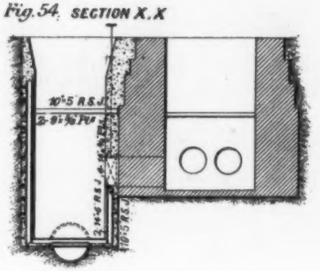


Fig. 55.

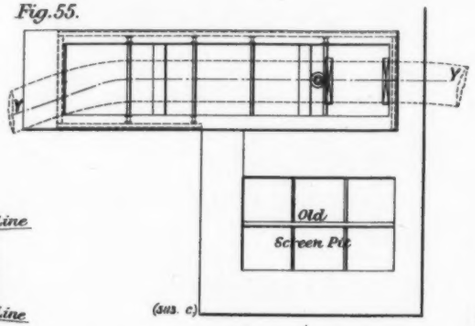


Fig 51

Fig. 62.

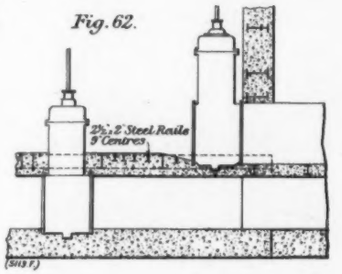


Fig 52

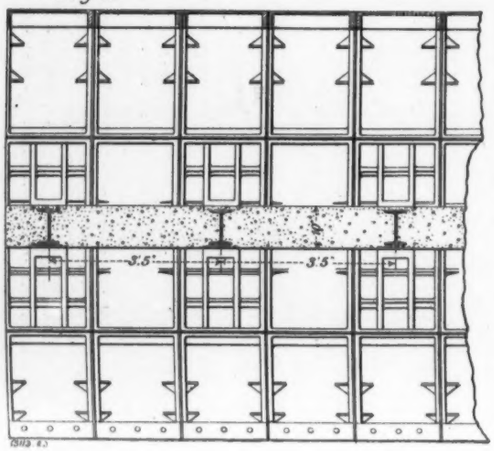


Fig. 56.

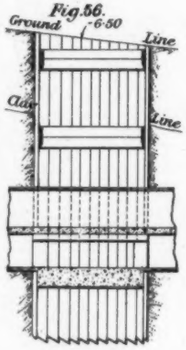


Fig. 57.

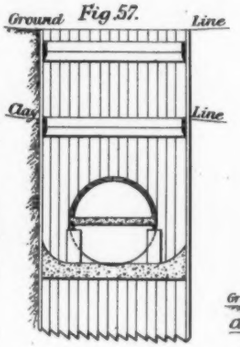


Fig. 59

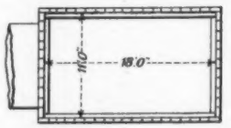
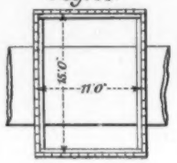


Fig. 58.



OUTLET SUMP

Fig. 60.

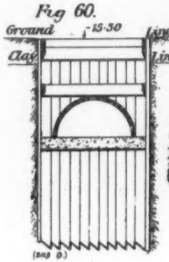


Fig. 61.

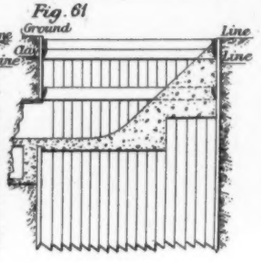
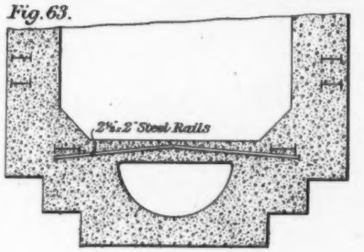
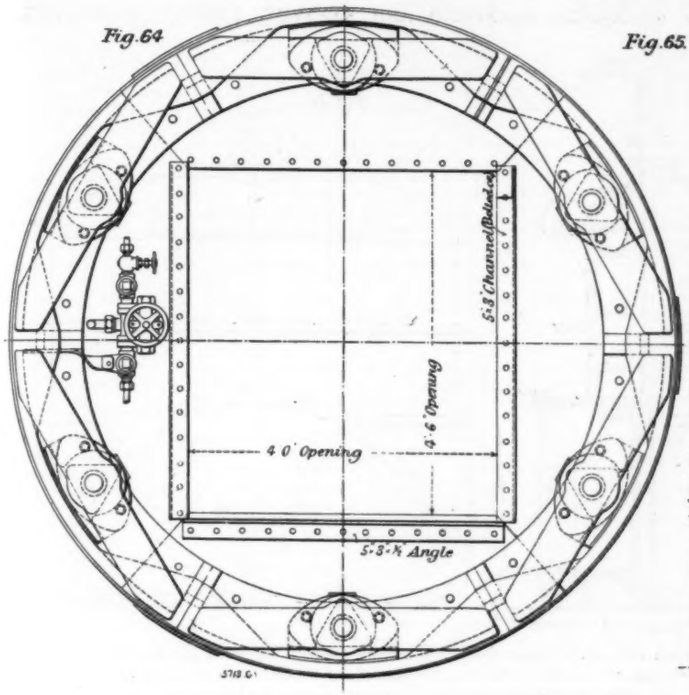
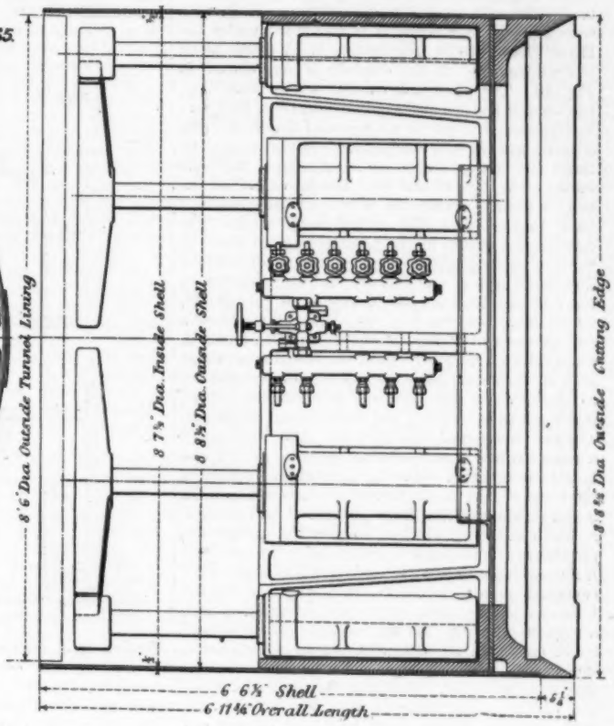


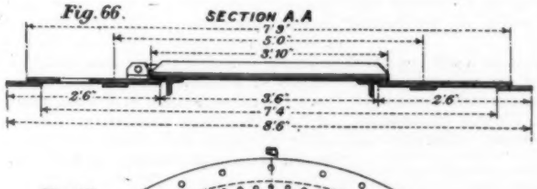
Fig. 63.

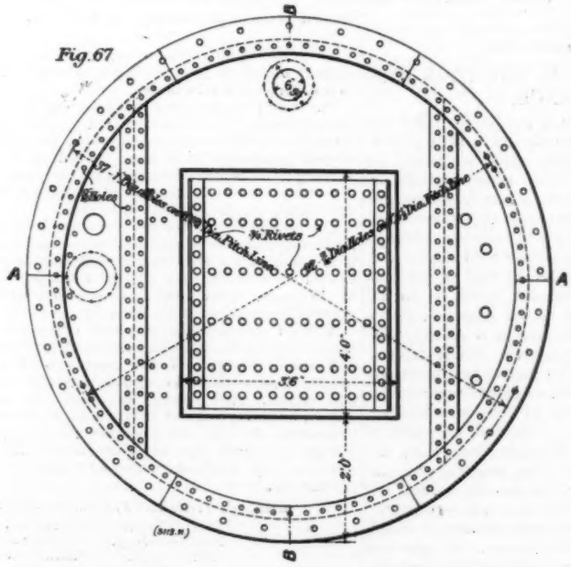


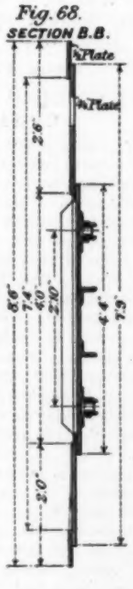
SHIELD AND AIR LOCK FOR WATER CONDUIT AT LOTS-ROAD POWER STATION.

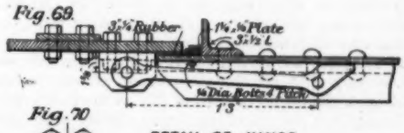


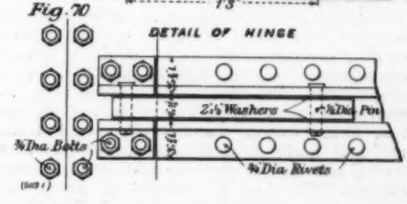












replaced, but it is interesting to note that use is made of two of the original cylinder piers built in 1869. These are being transformed into solid piers by enclosing each pair of them in a steel plate case filled with concrete. The new construction is being supported on pile foundations surrounding the old piers. The new east approach will consist of a steel viaduct with deck girders 8 ft. centre to centre, and consisting progressively from the east end of a 65 ft. 11 in. span, a 50-ft. tower span and two 65 ft. 11 in. spans, and one through riveted Pratt truss span 120 ft. 8¾ in. long. Commencing at the west end, the west approach will consist of one 65 ft. 11 in. span, a 50-ft. tower span of the same construction as in the east approach, and followed by two through riveted Pratt truss spans, 129 ft. 5¾ in. and 120 ft. 8¾ in. in length respectively.

The design and construction of the new bridge has been handled under the direction of E. E. Adams, consulting engineer of the Union Pacific System, at New York City; R. L. Huntley, chief engineer of the Union Pacific; and W. L. Brayton, bridge engineer at Omaha, Neb. The American Bridge Company have had the contract for both the fabrication of the steel and its erection.

15,000-KW. THREE-PHASE TURBO-ALTERNATOR FOR LOTS-ROAD POWER STATION.

(*Concluded from page* 518.)

THE provision of the circulating water required for condensing the steam exhausted from the turbine made it necessary to construct an entirely new conduit for abstracting the water from the Thames and restoring it again after its passage through the condensers. The execution of this work was entrusted to Messrs. John Cochrane and Sons, Limited, of 39, Victoria-street, S.W.

The general conditions which governed the design and lay-out will be understood on reference to Figs. 49 and 50, page 538. As shown in the plan view, the power station is situated on the north bank of Chelsea Creek, but for obvious reasons the intake and outlet for the circulating water have both been located in the deeper water of the main river, as indicated at A and B, Fig. 50. The condensers for the 15,000-kw. turbine are, however, at the western end of the power station, and it was considered undesirable to carry the

conduit directly under the station. It follows, accordingly, the path D C B A in Fig. 50, passing for part of the distance under Chelsea Creek, thence under the coal storage tank and barge basin to a screen pit at C, whence it is continued under the River Thames to its terminus at A. A profile along the centre line of the conduit is reproduced in Fig. 49. The work was carried out by tunnelling, the conduit being a built-up cast-iron tube, 8 ft. 9 in. in diameter, divided by a horizontal diaphragm (see Figs. 51 and 52) into two distinct compartments. Of these the upper serves as supply pipe, with its intake at A, Figs. 49 and 50. The lower half of the tube is used to return the flow from the condenser back to the river, the outlet being at B. The conduit lies wholly in the London clay, so that the work of tunnelling presented no special difficulties. The shield system was utilised, and we reproduce in Figs. 64 and 65, page 539, drawings of this shield, which was constructed to Messrs. Cochrane's requirements by Messrs. Markham and Co., Limited, Chesterfield. As will be seen, the shield is provided with six hydraulic rams, which are all coupled up to the pressure main through independent valves, making it easy to swing the shield round all curves, whether horizontal or vertical. The system of excavation was in all essentials the same as followed in the construction of the London tubes. Although the route chosen for the tunnel was believed to be in sound strata and free from pockets of bad ground, it was considered prudent to provide against the possibility of water-bearing seams being encountered. Hence air locks were fitted and the whole of the work executed under pressure. This did not exceed 1 lb. per square inch, which was maintained with a view to ensuring that the air locks should always be in condition to cope with an inrush of water, should such a contingency arise. Of these air locks two were provided. One was fitted at the upper end of the tunnel near D, Fig. 50, and this was used until the tunnel head had been carried out beyond the wharf edge on the main river, when a second air lock was put in as noted in the plan, Fig. 50. This was done in order to make it possible to complete the screen pit C in the open. It was necessary that all the components of this second air lock should be of such a size as to readily pass through the portion of the tunnel already completed and that they should be capable of ready removal on the completion of the work. Details of this lock are reproduced in Figs. 66 to 70, page 539. A ring of ½-in. steel, 7 in. wide, made in six sections, was clamped between two successive rings of the cast-iron tunnel casing. To this was bolted a steel bulkhead made in three sections, of which the central one was as large as could be conveniently handled. The door is provided in this section, and is swung on links hinged not merely at the jamb, but also at their connection to the door itself (see Figs. 69 and 70), so that the door always closes flat on its seatings.

Openings for telephone wires, water and hydraulic mains, and for the discharge of muck, &c., are provided in the bulkhead as indicated.

Details of the intake to the conduit are illustrated in Figs. 59, 60 and 61, page 538. The opening is, it will be seen, enclosed by sheet piling, the mouth of the conduit being constructed in concrete, with a clear passage-way at bed level of 18 ft. by 11 ft. At the outlet the river bed is higher, and longer sheet piling was required, as is shown in Figs. 56, 57 and 58, page 538. In this case the water discharged has to find its way out round the upper half of the tunnel tube, which, as already stated, serves as the inlet conduit. The clear opening at river-bed level measures in this case 15 ft. by 11 ft.

A plan and two cross-sections of the screen pit are reproduced in Figs. 53, 54 and 55, page 538. The new pit lies, it will be seen, on the north-east side of the existing screen pit, and is constructed in concrete, heavily reinforced with steel beams, and the opposing sides are strutted across by 10-in. by 5-in. steel joists, as best seen in Fig. 53. Under certain conceivable conditions it was found that the floor of the pit, which forms at the same time the roof of the discharge conduit, might be subject to a considerable pressure tending to burst it upwards. To guard against this contingency the arrangement indicated in Fig. 63 has been adopted, the effective span between side walls being shortened by filleting the corners, as shown; whilst the unsupported portion has been substantially strengthened by a steel rail reinforcement. The screens fitted are mounted on rollers, the lower one of which is not fixed, but merely rests on a concrete wall. The whole can therefore be swung up for cleaning or for examination.

As shown in Fig. 62, a shut-off valve, operated from the surface, is provided for each half of the conduit. These are sluice valves with semicircular openings, as shown in Figs. 71 and 72, annexed. They were supplied by Messrs. Glenfield and Kennedy, Kilmarnock.

SLUICE VALVE FOR LOTS-ROAD POWER STATION.

CONSTRUCTED BY MESSRS. GLENFIELD AND KENNEDY, LIMITED, KILMARNOCK.

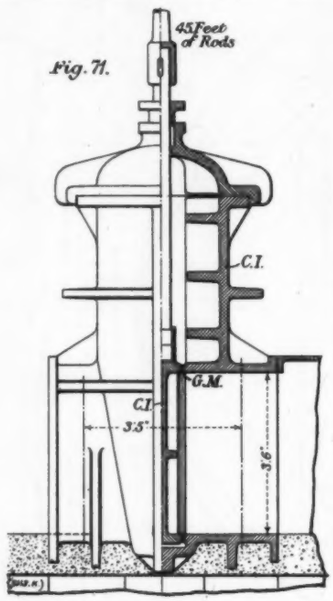


Fig. 71.

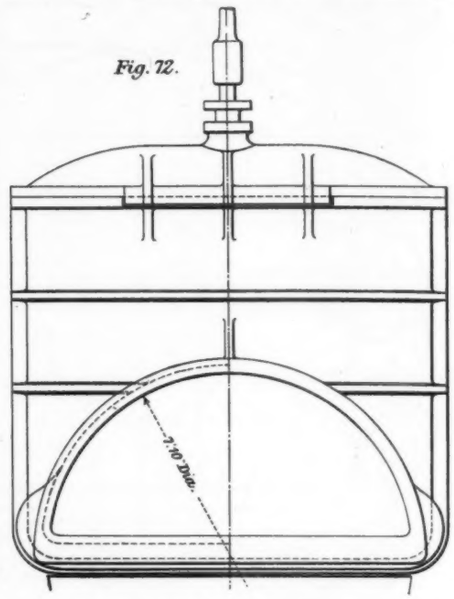


Fig. 72.

GERMANY'S HOLD ON THE IRON ORE OF FRANCE.

PEACEFUL penetration is a phrase to which we were well accustomed before the war, and to which, although it had a disturbing effect, we raised no serious objection. There were some protests in the press when Germans took a part in the search for Kent coal, and more emphatic objections when it was rumoured that they were buying collieries in South Wales. But the matter died down, and it was not until the war broke out that we realised how useful peaceful penetration could be to an enemy. As long as foreign capital is used in carrying on a complete manufacture in a country the advantages probably outweigh the disadvantages, but when it is employed to secure raw material, or half-finished material, then a serious danger arises, for it prevents the creation of the corresponding industry. If this industry is essential, especially if it is an important factor in waging war, then the country which is the scene of the peaceful penetration is not only the poorer but also the weaker.

Apart from coal, Great Britain is not very rich in raw materials, and therefore did not attract much German capital, except in finance. It was our Colonies that were made the scenes of monopolistic strategy rather than ourselves, and they have had to take drastic measures to free themselves from the web which was woven around them. France, lying close to Germany, naturally came in for a great share of attention, especially in relation to its iron ores, although every detail of its life and business was studied with minute care. To show how strenuous were the German iron-masters, backed by the financiers, in their attempts to possess themselves of French ore deposits, we give below very long extracts from a German report on the subject, prefacing them with the following quotation, which is a text that needs no sermon to carry its meaning home:—

"Through the stringent organisation of the German export trade to France, and through the systematic distribution of agencies over the whole country, the German industry was enabled to form a clear picture both of the capacity of the French industry and of the buying capacity of the inland market in France. German commercial travellers have been the pioneers in France, who showed the way to the German industry. They visited the whole of France and offered their goods with well-known German persistency and tenacity."

Three divergent views prevail in Germany as to the manner in which German industrial and commercial expansion should take place.

One view is to the effect that Germany should forego the enlargement of her area and confine herself to commercial and industrial conquests; for this purpose several companies have been formed of late years. It is argued in favour of this view that German industry can easily absorb the increase of population, and that agriculture, besides, is short of labour.

The opposite view favours the acquirement of new lands, especially for agricultural purposes. If industry is to absorb some 800,000 to 900,000 hands annually, the entire social balance will be upset in the course of 20 years. This additional acquirement of land must be brought about by the war.

A third group advocates land expansion outside Europe, especially for the purpose of procuring fresh and ample supplies of raw materials for German industry, particularly as regards vegetable substances and metals. New sources of supply for ores and metals, however, can also be secured without such land expansion, viz., by the purchase of ore deposits in foreign countries, by acquiring shares in mineral concerns, by contracts extending over protracted periods, &c.

Germany's Trade with France, 1902-1912.

	France's imports from Germany. Mill. francs.	France's exports to Germany. Mill. francs.
1902 ...	418.2	487.4
1903 ...	444.2	512.8
1904 ...	428.8	555.3
1905 ...	477.2	628.8
1906 ...	583.4	640.3
1907 ...	638.2	649.7
1908 ...	607.5	617.1
1909 ...	661.1	725.9
1910 ...	860.5	804.0
1911 ...	979.7	794.6
1912 ...	999.2	821.7

This latter form of the industrial and commercial expansion of Germany is to be met with in France. Germany's commercial dealings with France have

developed so rapidly during the last decade that they now are next in importance to those of England. Germany's turnover with France has risen from 905,600,000 francs in 1902 to 1,820,900,000 francs in 1912, and the table on the preceding page shows how the balance has tended in favour of Germany, the latter country's exports to France being materially in excess of the imports into Germany from France, whilst the reverse was the case so late as 1909.

In connection with these figures it must be noted that France's imports from Germany, with the exception of coal and coke, which in 1912 amounted respectively to 3,182,000 tons and 2,299,000 tons, almost exclusively consisted of finished goods, whilst her exports to Germany were principally raw materials. Germany's trade has therefore been much the more profitable of the two, viewed from the standpoint of national economy, inasmuch as that country is short of raw material for her heavy industries, especially her iron industry. As regards coal deposits and coal production Germany is steadily attaining the output of England and the United States, but in the matter of iron ore and metals she, to no small extent, depends upon foreign supplies.

The production of iron plays a most important part in Germany, her output being next to that of the United States, having left that of England materially behind. Yet it is capable of considerable further expansion, for the attainment of which the acquisition of iron ore deposits, under her own flag, is a most essential matter. This object was largely the cause of the Morocco question, and German iron-masters continue to make the greatest efforts to become possessed of good iron ore deposits, particularly in the French plateau of Briey and in Normandy. The world's consumption of pig-iron, and consequently also its production, is continuously increasing, and the result is that it becomes more and more difficult for a country like Germany, which does not possess sufficient iron ore deposits within her own borders, to obtain the necessary supplies. Germany's production of pig-iron in 1910, for instance, had a value of 766,000,000 marks, and of this production 6,800,000 tons, representing a value of 340,000,000 marks, were exported. Germany is only enabled to carry on this remunerative business by imports of iron ore from foreign countries. During the year 1910 there came to Germany from Sweden, 3,248,995 tons; from Spain, 2,861,288 tons; and from France, 1,773,809 tons. The two following years the figures were :—

	1912.	1913.
	Tons.	Tons.
Sweden	3,875,000	4,558,000
France	2,691,000	3,811,000
Spain	3,726,000	3,632,000

Sweden's deposits of iron ore are estimated to contain some 1,200,000,000 tons, of which about 105,000,000 tons are in Central Sweden, while the bulk is in the various Lapland deposits. Germany, however, has serious apprehensions as to the export of Swedish ore being handicapped by duties, increased railway rates, &c., Sweden being anxious to develop her own iron works as much as possible. When the German-Swedish commercial treaty was renewed in 1911 Herr Delbrück stated that it had been extremely difficult to maintain the *status quo* as regards iron ore.

The Bilbao deposits are not likely to prove of much importance to Germany for the future, inasmuch as they are likely to be exhausted before long, the residue being estimated at only some 50,000,000 tons, and the imports to Germany of Spanish ore, as will appear from the above figures, are already on the decline.

France is the country which offers the best prospects for supplying Germany with iron ore for the future. The iron ore deposits of the department of Meurthe-et-Moselle are estimated, both by French and German experts, to contain fully 3,000,000,000 tons. France now wants to cut off this supply from Germany, but no one knows what the future has in store. In the meantime it may be of interest to see the extent to which Germany was interested in French iron ore mines and the French iron ore trade when the war broke out. In this connection the minette deposits, especially those of the Briey districts, and the ore deposits of Normandy, are of importance. The French minette district covers an area of some 151,000 acres (against 106,000 acres in German Lorraine, 9,100 acres in Luxemburg, and 874 acres in Belgium). The Briey ore contains 37, in some cases even 40, per cent. of iron, whilst that of Longwy and Nancy only contains 33 per cent. The output of iron ore in the department of Meurthe-et-Moselle has increased at a very rapid rate, and amounted in 1912 and 1913, respectively, to 17,235,000 tons and 19,813,000 tons, whilst the entire production of iron ore in France during the latter year was 21,714,000 tons.

The deposits in Normandy extend over some 39,000 acres in the departments of Calvados, Orne and Manche. These ores contain as much as 53 per cent. iron, and the output has risen from 162,400 tons in 1902 to 609,000 tons in 1911. About one-third of the output is worked up in France, and of the balance two-fifths go to England and three-fifths to Germany. The Thyssen blast-furnaces at Caen, which were to have started operations in 1915, were designed to work up all this ore on the spot, and thus there would have been no export. The capacity of these deposits is estimated from 110,000,000 tons to some 700,000,000 tons.

Whilst France thus is rich in iron, she is poor in coal. Her production of coal in the year 1912 amounted to 41,310,000 tons, against a consumption of 59,622,000 tons, a deficit of close upon 20,000,000 tons, which in the year 1911 meant an expenditure of some 400,000,000 francs. Germany, on the other hand, has plenty of coal, the production having risen from 120,815,503 tons in 1904 to 191,511,154 tons in 1913, of which 34,573,514 tons were exported, 3,242,175 tons going to France, besides 2,354,918 tons of coke. Thus France, with her ample wealth of iron ore, and Germany, with inexhaustible riches of coal, seem intended by Nature to supplement each other, but political considerations have raised a barrier between the two countries. The German-Franco Industrial Union was intended to bridge over this gulf, but the war has frustrated these efforts. The French, it must be admitted, in many instances did not view these endeavours with favour. The German attempts to secure a share in the French iron mines were denounced as a national danger.

This German invasion began about the year 1900, and has, in a way, been continued ever since. A list, carried to 1906, comprises the following concessions to German firms :—A. Thyssen (1,700 and 2,550 acres, Briey); German Luxemburg Mining Company, 25 per cent. (1,720 acres, Briey); Luxemburg Mining and Saarbrücken Iron Works Company (2,340 acres, Briey); Röchling and Co. (216 acres, Longwy); Röchling and Co., 50 per cent. (2,190 acres, Briey); Aachen Iron Works, 7 per cent. (803 and 617 acres, Briey). This list has been materially swelled since then, as will appear from the following particulars, and in addition Germany has drawn iron ore from many other French sources.

Germany's imports of French iron ore have increased at a rapid rate, from about 20,000 tons in the year 1901 to 3,811,000 tons in the year 1913; about 90 per cent. of this total came from the Briey district. On the other hand, France received a great deal of coal from Germany, the department of Meurthe-et-Moselle in the year 1910 taking 2,882,000 tons, while the export of iron ore to Germany from the same district that year amounted to 1,400,000 tons.

France's supply of iron ore to Germany was based partly on incidental purchases, partly on contracts extending over a long term, partly on a share in the iron ore deposits, and partly on German acquirement of French iron mines. For the sale of iron ore from the Briey district a sale bureau was constituted in the year 1910, for five years, under the style of *Comptoir de Vente de Minerals du Bassin de Briey*, which comprised the following six important concerns :—(1) Société Anonyme des Hauts-fourneaux et Fonderies de Pont-à-Mousson (the Auboué-Moineville mine); (2) Compagnie des Forges et Aciéries de la Marine et d'Homécourt (the Homécourt mine); (3) Société Marc Raty et Cie., at Saulnes (the Sancy mines); (4) Société des Aciéries de Longwy (the Ticqueguieux-Bettainvillers mine); (5) Société Anonyme des Forges et Aciéries du Nord et de l'Est (the Pienne mine); (6) Société Anonyme des Aciéries de Micheville (the Landres mine). All these concerns have a considerable output, the figures for 1913 being respectively 2,009,000 tons, 1,783,000 tons, 688,000 tons, 1,113,000 tons, 1,131,000 tons, and 1,088,000 tons. As far as the German Customs Union is concerned the representative for this sale bureau resided in Luxemburg.

The German iron industry has also found methods, apart from direct contracts and trading, of becoming possessed of French iron ore. Amongst the foreign concerns which succeeded in becoming interested in the Normandy iron mines, on their being opened out, was also the Société Française de Mines de Fer. In spite of its French title, and of it being domiciled in Paris, it is an exclusively Dutch concern, which really does most of its business in Rotterdam. The head of the concern has secured concessions for 8,650 acres in the Normandy mining district, altogether four concessions in the departments of Calvados and Manche. All the ore from these concessions, which are only being opened up, goes to Germany. There is also German money in the concern—for instance, the Stinnes firm has contributed 1,500,000 francs, and other leading German firms have arranged for long-term contracts; thus the large Thyssen concern had one for 10 years, the Friedstruppe firm for 200,000 tons annually, &c.

The German shares in French-owned mines principally relate to mines in the minette deposits of eastern France, especially in the Briey district, viz., those of Valleroy, Jarny, Sancy, Murville, Moutiers, Conflans, Serrouville, Errouville and Bellevue, with an aggregate area of 16,500 acres.

The concession of Valleroy is mentioned as a model for an industrial understanding between Germany and France. The area covered by the concession is 2,189 acres, under the control of the Société des Aciéries de Longwy; the deposits are rich in ore and are located close to the iron works, but the company has to buy all its coal, and it was therefore found desirable to bring about an exchange, giving the concession of part of its ample iron deposits for a share in a German coal concession. A contract was consequently entered into with the firm of Röchling Brothers, of Saarbrücken, for a period of 99 years from June 25, 1907. The concession by the French company referred to Valleroy; the German was part of the Karl Alexander coal mines at Bäsweiler, with an area of 8,860 acres. The French concern, to begin with, took one-fourth part, for 5,000,000 marks, with the option of extending it to the half before the end of five years. In return the Longwy company receives its share of coal and coke at cost price. In return the Longwy company, against the payment of 4,000,000 francs, gave the firm of Röchling Brothers a share up to one-half of the ore from the Valleroy concession, a company being formed with a capital of 9,000,000 francs, the French company receiving 8,025,000 francs in shares. Of these 16,050 shares 8,000, after the lapse of two years, had to be handed over to Röchling Brothers as their part in the business, the two brothers Röchling to be on the board, but the Longwy company to have the majority of directors, as did the German firm in the coal mining company just referred to. The output of the Valleroy deposits are divided evenly between the French and the German companies. The report of August 27, 1913, states that the output for the year 1912–13 amounted to 221,540 tons.

This principle of reciprocity has not been followed up by other firms. Thus the concessions of Jarny and Sancy belong to an industrial group, in which the German element prevails, through the medium of the important German concerns, the Phœnix Company (by the Haerde concern), the Haspe Company, and the Holsch Company. Although the Phœnix Company owns mines covering 195,000,000 sq. m., in Lorraine, Siegerland, Nassau, &c., she cannot cover her requirements of iron ore without falling back upon foreign supplies. The Jarny concession was, in 1906, transformed into a company by the holders, the Société Métallurgique de Senelle-Maubeuge, with a capital of 6,000,000 francs, soon raised to 12,000,000 francs. To begin with the French and the three German companies divided both the ore production and the costs in equal parts, but later the company passed principally into the hands of the three German firms.

The Murville concession, 1,225 acres, has been handled in a similar way; in 1907 it was transferred to a company with a capital of 10,000,000 francs in 20,000 shares of 500 francs, of which 16,000 shares went to the Senelle-Maubeuge Company, of the balance the German Aumetz-Friede concern secured 950 shares, the remainder being subscribed by the directors of Senelle-Maubeuge. By degrees almost the entire share capital (in 1911, 9,591,000 francs) has passed into the possession of the German company. The production of ore amounted to 422,600 tons in 1913.

The Moutiers concession (1,719 acres) was formed into a company in the year 1900, by one French, two Belgian, and one German concerns, the latter being the German Luxemburg Mining Company. The four companies are interested in equal amounts of 2,500,000 francs; the production in 1913 was 920,000 tons.

The Conflans concession (2,068 acres) was in 1907 formed into a limited company by two French concerns, there being 200 portions, they themselves keeping 100, the German Dillinger Company, at Dillingen on the Saar, securing 70 portions, 10 going to a Belgian iron works, and the balance to other French works. Working has not yet commenced.

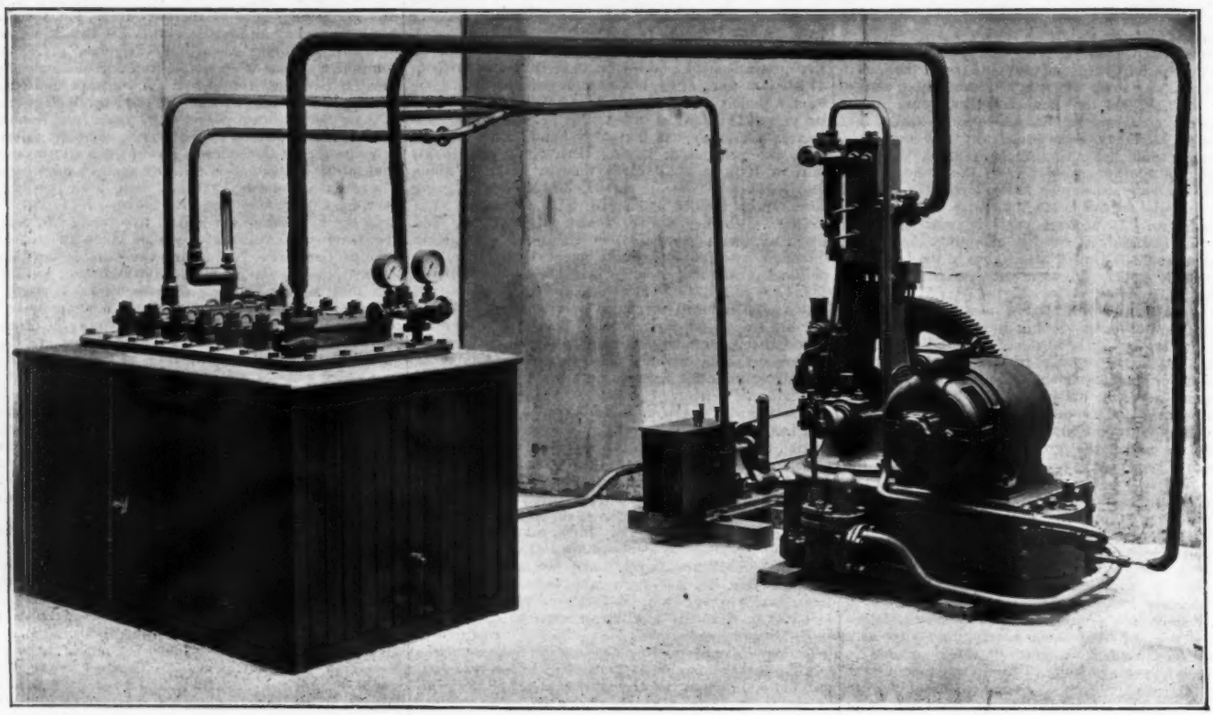
The concession of Serrouville (1,779 acres) was formed into a company with a capital of 600,000 francs. The French concession holder and the German concern of St. Ingberter Ironworks are interested

The German Burbach concern is interested in the Errouville and Bellevue concessions, but although the Burbach concern has become a member of the large Luxemburg combine Burbach-Eich-Didelingen, with its domicile in Luxemburg, these two concessions should be mentioned here, as Luxemburg is included in the German Customs Union and as the important Burbach iron works mostly depend on Briey ore for their supply. These two concessions comprise respectively 2,342 and 1,455 acres. The former was turned into a company with a capital of 3,000,000 francs, of which the Burbach Company found one-third. The Bellevue concession was formed into a company with the same capital as the former (3,000,000 francs), in which the Burbach concern is also interested.

(To be continued.)

REFRIGERATING PLANT FOR INLAND TRANSPORT.

CONSTRUCTED BY MESSRS. J. AND E. HALL, LIMITED, ENGINEERS, DARTFORD.



To meet the requirements of the hospital service of the Mesopotamia Expeditionary Force a very compact little installation has been designed and made in considerable numbers by Messrs. J. and E. Hall, Limited, of London and Dartford.

These plants are one of the numerous adjuncts of the admirably equipped hospital service which has been developed since the early days of the Mesopotamia campaign. It may safely be said that no more perfectly equipped medical establishment exists anywhere, and that the officers of the R.A.M.C. who have prepared the specification in collaboration with their brethren of the Royal Engineers (which ancient corps, as is well known, now includes a number of highly experienced naval architects and marine engineers) have done their work thoroughly and to the ultimate great comfort of those of the combatant arms who may have the misfortune to become "casualties" in the trying climate of the Middle East.

As is well known, ice is an important feature in certain medical and surgical treatments, but apart from this consideration, cooling drinks are almost a necessity, and at least a great boon to those living under tropical conditions, whether they be well or ill. The cool storage of provisions for the dietary of the patients is also of the highest importance under climatic and general conditions which preclude the possibility of procuring daily supplies of perishables.

The accompanying illustration gives a good general idea of the plant as a whole, as erected in the makers' works, the only part which does not appear being the cooling pipes for a small cold chamber which will be fitted on each hospital vessel close to the machine and ice tank.

The CO_2 compressor, which is of the single-acting type, has metallic packing in the gland and piston, and is made from a solid block of high carbon steel. It is mounted on a light cast-iron frame and bolted on a hollow base casting which contains the copper CO_2 condenser coils. The same casting also carries the electric motor, which drives the crankshaft through machine-cut gearing with a rawhide pinion. The compressor gland is oil-sealed by means of the makers' differential lubricator, and there is an efficient oil separator. Water circulation is provided by a gun-metal pump driven from the crankshaft.

The CO_2 evaporator coils are contained in the ice tank, which is fitted with six galvanised steel moulds, each producing a block weighing 24 lb. The ice tank is neatly lagged with teak, and the brine is circulated in it and through the cooling pipes of the small cold chamber by means of an Albany pump driven from the crankshaft of the machine by a roller chain. This pump fulfils the double purpose of stirring the brine in the ice tank and thereby increasing the rate of freezing, and of promoting an active circulation in the cooling pipes of the cold chamber.

The aim of the makers throughout has been to simplify the connections as much as possible and thereby facilitate the erection and running of the plant under the severe conditions which will obtain on service. The trials which have been carried out at the makers' works have reproduced these conditions in their extreme form, and the plants have stood up to the test with a satisfactory margin.

4½-INCH CAPSTAN LATHE.

WE illustrate on the opposite page a very neat 4½-in. capstan lathe, constructed for Messrs. Richard Lloyd and Co., of Galton Works, Steelhouse-lane, Birmingham, by the Turner Motor Manufacturing Company, Wolverhampton. It will be seen that it is constructed to take bar stock, which is fed through the hollow spindle up to the chuck by a hand lever and a counterweight.

In addition to the usual features of such a lathe there is a new cut-off attachment which greatly increases the range of work for which it is adapted. This consists of a cut-off slide mounted on a sliding saddle between the headstocks. On the slide there are back and front tool posts, so that cutting can be done from both sides, and close up to the face of the chuck. These tool posts are arranged for adjusting the height of the tools without the use of loose packing.

The sliding saddle is moved by means of a hand-wheel—seen in front of the fast headstock—acting through mitre wheels and a screw, and its travel is fixed by adjustable dead stops in front of the bed. The tools are fed in by means of a screw or rack and lever, a small handle instantly engaging either motion. Dead stops are provided, and are in full view of the operator. The countershaft is provided with two sets of pulleys of different sizes, to give two speeds, one set being designed for open and crossed belts for reversing the lathe spindle.

MERCURY-VAPOUR DIFFUSION PUMP.—We described last year the new diffusion pump of Gaede and the shapes which Langmuir had given to these new mercury-vapour pumps for high vacua. In the *Physical Review* of April, 1917, C. T. Knipp describes a modification of these pumps which looks simpler and does not make so high claims upon the skill of the glass-blower.

REFRACTORY MATERIALS SECTION OF THE CERAMIC SOCIETY.

(*Concluded from page* 519.)

MAJOR C. W. THOMAS read a paper on "Scientific Management and its Application to Firebrick Works." In it he says the application of systematic organisation to the control of the factory is not new, but the modern conception of scientific management is of comparatively recent growth.

Scientific management implies that each step in the process of manufacture has been thoroughly investigated by the best experts available; that when this has been done, specific definite instructions for each stage through which the work has to pass have been reduced to writing, so that nothing is left to chance; that returns come into the head office daily, showing how the work has progressed; that any delay or failure to carry out the instructions is at once reported to the office, and a proper person helps to remove the obstacle, so that the work can proceed, and if possible catch up with the time-table; that the special requirements of the purchaser in each case are known; that the possibilities and limitations of the raw material are understood, so that it can be adapted to requirements; that results are predetermined; that all work is executed on a prearranged plan, based on competent observation and accurate records. Predetermination of results may be considered the chief feature of scientific management, older methods being distinguished by the acceptance, as a matter of course, of haphazard results.

Scientific management may be defined as the application to the direction and control of a factory of those methods of investigation which have proved to give the best results in the realm of pure science, and the basing upon the information thus obtained of a considered and logical scheme of working, directed to obtaining the highest standard of excellence in the finished product.

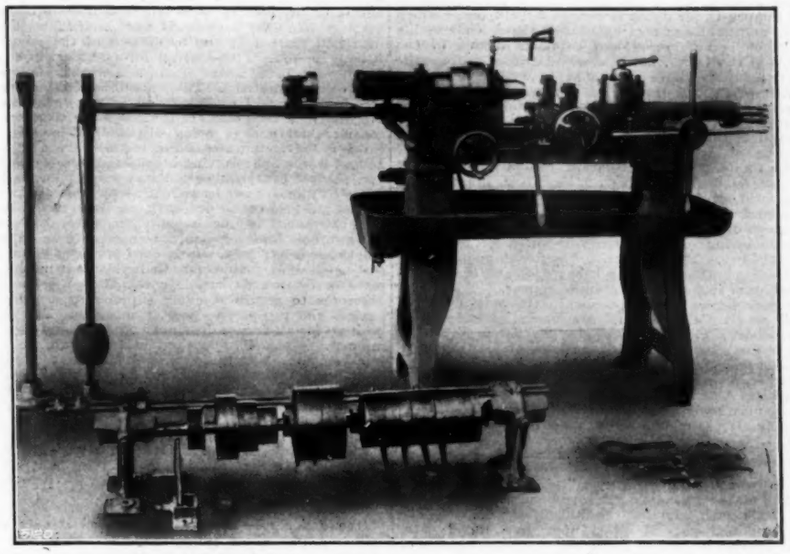
The conditions involved in scientific management include:—

1. The separation of planning from performance. The planning in advance (which is the essence of the whole) should cover the whole process of production, extending into every detail that will help to secure the perfect product. A man engaged in executive work cannot devote his whole attention to planning work which has yet to come through.

2. The acceptance by the management of responsibility for seeing that the worker performs his duties

4½-IN. CENTRE GALTONA CAPSTAN LATHE.

(*For Description, see opposite Page.*)



under the best conditions, that he is told definitely what to do and the best way of doing it, and that he is supplied with the best appliances for doing his work.

3. Work must be accomplished under a definite schedule of instructions and its execution checked systematically, delay and error being prevented instead of corrected.

4. Each operation must be carefully studied to ascertain what time it should take normally, and whether it can be done in a better way than the customary one. This saves time, labour and material.

5. Accurate records must be kept of all work done and all results obtained for each individual and each machine, for without them it is impossible to judge how far results obtained approach the standard fixed by the previous analytical study, but with them each man is sure of fair treatment, waste of time and material can be controlled, and the efficiency of every factor in the works can be maintained.

6. Standardised methods of work and equipment are essential. There are always several ways of doing a particular piece of work, but all cannot be the best. Each man must use the best method (as determined by analytical study) and no other.

The introduction of scientific management is a gradual process, as the men must be taught the new methods, and to accommodate themselves to new ideas. This is never easy, but when the men get to understand the principle involved their co-operation may be relied upon.

The principles of scientific management are applicable to any form of industry, highly complex or relatively simple, and their adoption need not cause any large expenditure. The increased efficiency of existing plants will usually give greatly increased production without any additional capital outlay for plant extensions.

The true function of science is the proper observation and classification of facts and the recognition of their right sequence and relative importance. The habit of basing correct deductions and sound judgments upon facts is the greatest characteristic of the scientific mind. This method of examining facts can be applied to any class of problem, chemical, physical, social, or psychical, and by any person, whether a professional scientist or not. But a man who has been trained in some branch of natural science will doubtless acquire the method more thoroughly than one who has not been so trained.

Reference was made to a number of books treating of the subject or parts of it.

It has become of vital importance to consumer and maker alike that the conditions under which firebricks have to work should be known and studied, and that both materials and methods of manufacture should be adjusted accordingly. The applications of the method in the case of a firebrick works would have to cover a wide field, the chief headings being as follow :—

1. Mining and selection of raw materials.
2. Requirements of various industrial processes in refractories.
3. Blending and preparation of bodies.
4. Methods of making.
5. Drying and burning.
6. Utilisation and direction of labour.
7. Costs.

As regards materials, the chemical and physical composition and fusing point should be known, and the physical changes that the clay undergoes when heated to temperatures below the fusion point, as well as its behaviour at furnace temperatures under different loads. These data should be checked and revised periodically, so that any changes in the seam may be allowed for. The effects of varying texture and of different proportions of grog should be studied, and the action on the brick of different gaseous atmospheres, of ash and of slag.

By means of these data, duly tabulated, the maker may know exactly what materials are best adapted to specific conditions.

Methods of moulding and making offer great possibilities as a field for investigation, and mechanical methods might be extended with very considerable advantage.

Drying and burning are also open to improvement. Gas-firing has not hitherto been taken up to any great extent in this country, but seems worth considering in view of the present price of fuel. Producer gas is in general use in many industries, and there is no valid reason why it should not be more commonly used for brick burning. The steam-heated drying floor is hard to beat for low cost when exhaust steam is available, and some tunnel dryers are advantageous as regards reduced floor area and the more convenient handling of small bricks. A tunnel dryer suitable for dealing with all the products of the ordinary firebrick works has not been devised yet, but it is worth investigation.

The author describes a new method for controlling the firing of brick-kilns by the use of a device intended to give a clearly visible indication of the progress of shrinkage in a test-block of about the size of an ordinary firebrick, so that the burner can judge of it without withdrawing trials from the kiln. It consists of a fireclay tube placed in the top of the kiln, supported by a flange resting on the crown of the kiln, and perforated to allow the hot gases to circulate through it in contact with a test-block in the form of a cylinder of dry unburnt fireclay of the regular body in use. Resting on the test-block and projecting through a thick asbestos packing is a second cylinder of burnt fireclay, which by a connecting rod supports an index lever, one end of which is mounted on a standard, the other end passing over a graduated scale. One inch of shrinkage in the test-block will cause the end of the lever to pass over ten inches of the scale, giving easily legible readings. Assuming the correct shrinkage of the clay to be known as a percentage of the unburnt dried brick, the direct reading on the scale will show when this has been attained in the test-block, and after this a certain additional time (to be ascertained by trial) will be required for the heat to soak to the bottom of the kiln and for the burn to be completed. No correction should be needed for the expansion of the fireclay tube when fully heated, as the test-block would then be at the same temperature and would be fully burnt also. No fancy claims are made for the contrivance, which is merely offered as a suggestion.

The burner ought to be provided with some means of gauging the progress of the burning, and also with a chart or guide showing the rate of progress normally. Some further suggestions are made respecting the use of charts for the setting, burning and drawing of kilns, for keeping a close check on the regular use of kilns and at the same time avoiding the necessity of having to go to the works to know the state of each kiln.

As regards labour, the subject of fatigue is further discussed, and the question of technical instruction of the different classes of workers. Finally, the question of costs is considered briefly.

In the evening Dr. J. W. Mellor delivered a popular lecture on the subject of "Black Cores in Fireclay Goods." He remarked that black coring may be regarded as a disease which affects firebricks and results from unhealthy conditions—for the bricks—during the firing. In mild cases there is nothing to show that the brick is any the worse. The symptoms are the appearance of a dark greyish or bluish-black core in the interior of the brick, and this may be anything from a small spot to a large mass extending throughout the whole interior. The cores may appear more or less fused, and in a very bad case the core may be a porous mass with a structure similar to that of pumice stone.

Black cores contain much carbon, or ferrous iron in comparatively large amount, or both ferrous iron and carbon.

Clays give off water when heated, and at a temperature not much above 100 deg. C. all the water used in making the clay plastic is driven off. At a temperature near dull redness clay loses a further quantity of water amounting to about 10 per cent. of its weight. (The proportion of water in fireclays usually ranges from 5 per cent. or 6 per cent. to 10 per cent. or 12 per cent., or even 14 per cent. in rare cases, but 10 per cent. may be taken as a general average.) At 500 deg. C. the steam formed from this second lot of water has a volume between thirty and forty times the actual volume of the bricks in the kiln.

Ferrous iron occurs when clays are heated in the presence of carbonaceous matters, or when there is a deficiency of air; ferric iron is produced when the clay is heated in the presence of plenty of air. The gases inside the kiln are collectively called the atmosphere, which is a reducing atmosphere if it favours the passage of ferric to ferrous iron, and an oxidising atmosphere if it favours the passage of ferrous to ferric iron. Fireclays contain from about ½ per cent. to 2 per cent. or more of iron reckoned as ferric oxide; the red-burning clays contain 5 per cent. or more. Clays with larger proportions of iron pass gradually into iron ore (clay ironstone).

Iron oxide is practically the only natural agent for colouring firebricks, the normal colour after firing ranging from shades of cream and buff to a deep red, due mainly to the ferric iron present. The colour produced by ferrous iron ranges from various shades of grey and purple to the deep bluish-black colour of Staffordshire blue bricks.

Fireclays contain up to 2 per cent. or more carbon, 1 per cent. or 2 per cent. being common. The carbon in some fireclays occurs in a form resembling bituminous coal, in others in a form resembling anthracitic coal, and a third form of carbonaceous matter consists of partially decayed vegetable tissue, and all intermediate gradations between these three occur. The carbon begins to burn out slowly from the clay at a dull red heat, vegetable tissue and anthracitic carbon causing no particular trouble. The bituminous carbon gives off a combustible gas, and if much be present the gas will burn at the surface of the clay and produce a local rise of temperature at the surface of the brick. Diagrams were exhibited showing the appearance of cores of bricks made from clay containing the different forms of carbon after various periods of firing. Time-temperature firing curves of kilns were also shown and explained.

If, when the kiln begins to show a dull red glow, air is circulating freely inside the kiln, the carbon begins to burn slowly from the clay. As the temperature rises the rate at which the carbonaceous matters burn off increases rapidly. The carbon near the surface of the brick burns off first, but, of course, the carbon cannot burn if the supply of air be cut off. As the air attacks the carbon in the interior of the brick, the passages between the grains or particles of clay become choked with a spent air which must gradually diffuse outwards, giving place to fresh air before more carbon can be burnt, and as the core becomes smaller it becomes more and more difficult for air to penetrate into the interior of the brick. Thus time is needed in order to get rid of the carbonaceous matters in these clays, mainly to ventilate the very numerous capillary

passages between the grains of clay, which serve as lines of communication between the interior and exterior of the brick.

As the temperature approaches 900 deg. or 1,000 deg. the capillary passages begin to close up, and the circulation of air between the interior and exterior of the brick is hindered or shut off altogether. It is important to get rid of the carbonaceous matters in the clay before the contraction has made much progress, and this gives a range of 600 deg. to 900 deg. as most favourable for the burning of the carbon, which may be called the period of oxidation. With some clays 900 deg. is rather high, but with most fireclays it is rather low. With these limitations, the higher the temperature the faster the rate of oxidation.

So long as carbon is present in the interior of the brick the iron in the clay will be in the dark-coloured ferrous condition, or even in the metallic state. When both iron and carbon are present the air burns the carbon, and converts ferrous iron into ferric iron. Ferrous iron heated in contact with clays forms a fusible mass just over 1,000 deg., but ferric iron does not begin to fuse till well over 1,500 deg., so that ferric iron in clays when heated in an oxidising atmosphere may be regarded as a refractory material. If the temperature of a kiln be carried through the oxidation period while there is still ferrous iron present, the black cores will begin to fuse and form slag, and in bad cases the gas bubbles entangled with the fusing slag cause it to swell and bloat, so that the cores will sometimes float on water. This slagging makes black-cored bricks sometimes appear tougher when tested cold in the crushing machine; it also explains how bricks show a greater after-contraction when tested in a reducing atmosphere than when tested in an oxidising atmosphere. If steam lags in the kiln near the bricks it will act as a barrage or buffer between the bricks and the outside air. Good ventilation means rapid oxidation. The mode of setting the bricks in the kiln which ensures the best circulation of air will be least favourable for black coring.

The formation of black cores is promoted by any variation in the materials or mode of manufacture which makes it more difficult for the air to circulate in the interior of the bricks. Thus the finer the grain, the more persistent the core. Any method of manufacture which gives a close compact body—as bricks made by the plastic process—tends to develop a black core. Conversely any method of manufacture which gives an open porous body—as in dry-pressed bricks—hinders the development of a black core. The use of poor coal in the early stages, followed by the use of better coal at a red heat, has often caused black coring. The lecture was illustrated throughout by samples.

At the business meeting held on Tuesday morning, the 22nd ult., Mr. W. J. Jones, of the Ministry of Munitions (Refractory Materials Department), was elected president of the Ceramic Society for the ensuing year, and the following gentlemen were elected vice-presidents of the Refractory Materials Section for two years:—Dr. J. E. Stead, Dr. H. G. Colman, Professor J. W. Cobb, Major C. W. Thomas, Messrs. A. Cliff, H. Brearley, J. Dunnachie, junr., F. Brooke, Bernard Moore, and C. P. Williams.

TECHNICAL JOURNALS FOR THE ARMY.—An appeal is made by the Motor Traction Publishing Company, Limited, 20, Tudor-street, E.C. 4, and Coventry, for the supply of technical and specialised journals to the Motor Transport Section of the Army Service Corps. The appeal states that the lack of technical journals is especially regrettable in view of the fact that men employed both in driving and in the workshops are unable to keep pace with current events and practice. New ideas are missed, and there is no doubt that if current issues and back numbers, after they have been perused by readers, can be collected and forwarded, they will prove most valuable and acceptable. With that end in view the company add that they have been able to make arrangements for the forwarding of all such journals to the M.T., A.S.C. They should be sent to the company, addressed, post or carriage paid, to the business manager.

THE COMMERCIAL MOTOR USERS' ASSOCIATION (INCORPORATED).—*Damage to a Weighbridge.*—We are informed that the Commercial Motor Users' Association has just been successful in winning an important action on behalf of commercial motor users. A claim of 85*l.* 10*s.* was made by the Towcester Gas Company against a member of the association for damage to the plaintiffs' weighbridge in Watling-street, caused by the defendants' steam lorry being driven over the weighbridge and through it. The plaintiffs sought to prove that the defendants were trespassing in that the weighbridge was only dedicated as part of the highway subject to the limitation that only carriage traffic of such weight as could be borne by it should pass over it, that the driver was guilty of an unlawful act in being on the wrong side of the road, that the lorry carried insufficient lights, and that the lorry was not duly licensed or registered. Justice Radcliffe found for the defendants on all these points and gave them judgment with costs against the gas company.

INSULATED ELECTRIC WIRES AND CABLES.

REVISED regulations have been issued by the Ministry of Munitions as to the manufacture and supply of insulated electric wires and cables. Under these regulations, dated June 1, 1917, the exemption from the terms of the Copper Order dated December 8, 1916, under which wires and cables of small size used for interior wiring could be manufactured and supplied outside of the terms of the Order, has been withdrawn. As from the above-mentioned date consumers not entitled to priority certificates Class A and Class B (P 5) may obtain supplies of insulated copper wire without a priority certificate, provided that they are able to satisfy the manufacturer or supplier that the goods are to be used solely for the purposes of repairs and maintenance.

The Cable Makers' Association, Sardinia House, Sardinia-street, Kingsway, W.C. 2, have been granted permission to obtain a limited monthly supply of copper for distribution among manufacturers, whether they be members of the association or not, for the purpose of manufacturing insulated wires required for repairs or maintenance. The association has been appointed the controlling authority, and is held responsible for the distribution of this monthly ration of copper.

Manufacturers requiring copper for this purpose should apply to the Cable Makers' Association at the address given above. The regulations provide that in respect of new orders existing stocks of insulated copper wire may be used only for repairs and maintenance, unless required for a Government contract, or for work covered by a Class A or P 5 priority permit. Copies of the regulations may be obtained from the Ministry of Munitions, Priority Department, 1, Caxton-street, Westminster, S.W. 1.

"COMMERCIAL PHOTOGRAPHY."—This is a useful little book of hints on the taking of a great variety of subjects and deals with some of the difficulties which the all-round photographer is called upon to contend with. Consideration is given to the arrangement and lighting of machinery, motor vehicles, furniture, &c., which may need to be photographed, whilst the after-treatment of the negative and the prints comes in for a share of the author's attention. The book is issued by Messrs. Henry Greenwood and Co., Limited, 24, Wellington-street, London, W.C., at the price of 1*s.* net.

THE LATE MR. JOSEPH RUSSELL, SHIPBUILDER, PORT GLASGOW.—We regret to learn of the death, on Sunday, the 3rd inst., at a nursing home in Glasgow, of Mr. Joseph Russell, one of the founders, and for long partner, in one of the shipbuilding yards on the Clyde, which turned out a large volume of tonnage each year, principally of the useful cargo-carrying type. Indeed, in this the firm specialised, and attained a remarkable degree of success. Mr. Russell was a son of the Rev. Joshua Russell, of Lewisham, and was born in London 84 years ago. He was educated at Mill Hill School and at London University. He served an apprenticeship as a shipbuilder in one of the old yards at Renfrew, and worked in one or two of the other Clyde yards. It was not, however, until 1874 that he founded the firm of Russell and Co., in association with Mr. Anderson Roger and Mr. William T. Lithgow. They started in a small way in what was known as the "Bay Shipyard," passing subsequently to a yard in Greenock, and finally to the Kingston Yard at Port Glasgow. Later they annexed another neighbouring yard. The co-partnery continued until 1891, when Mr. Russell retired from business, Mr. Roger taking over one of the firm's yards under the title of "Roger and Co.," while Mr. Lithgow retained the old firm's name and took over the other yard. Mr. Russell took a large part in the public life of Port Glasgow, in all its phases, particularly religious and social. In 1892 he presented the town with public bath and washhouses. In politics he was a Liberal, and took a leading part in connection with local Liberal affairs. He is survived by his widow and a family of two sons and six daughters.

THE GERMAN SCHOOL AT SHANGHAI.—If any evidence were needed of the justification which the French authorities had for taking over the control of the German "medical" school, it is supplied by the account published of the curious equipment of that building. The name "medical" as applied to the school becomes a pure farce. No doubt medicine was taught there: but how many other things? Every requisite, both chemical and mechanical, for the fabrication of bombs and explosives was there in abundance. There were models of shells and torpedo-boats, not usually demanded for the medical student's curriculum; and, finally, a hundred rifles. "We cannot positively say," says *The North China Herald*, as reported by *The London and China Telegraph*, "that the school was designed as a small arsenal; but the presumption thereof is strong, and the fact that it might have been so used beyond question. We particularly call the attention of our Chinese readers to these facts, because the Chinese Press has been making a great to-do about the alleged hardships inflicted on the Chinese pupils of the school by the seizure. It is not altogether easy to deal with these pupils, that is from the point of view of continuing their education; because they only speak German. But the suggestion that they have simply been turned adrift is absolutely false. The only "suffering" inflicted is that they must discontinue their studies in the art of making bombs and other lethal instruments. The students will continue their education at the Chinese Government School at Woosung."

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—Pits have now resumed work in entirely satisfactory fashion, and all traces of the holiday have disappeared. Several days were marked last week with irregular working, with the result that the effects of the holiday were felt in a more pronounced manner than otherwise would have been the case if the men had started at the expiration of the recognised holiday period. The demand for manufacturing sorts has become more active again, and works are eager to secure ample reserves. There is a brisk bidding for any free lots that find their way on to the open market, but contract requirements are too large to allow any considerable tonnage being disposed of outside their category. Current prices for inland sales are maintained. Inland works are receiving a good tonnage of gas fuels, and there is every indication that a big effort is being made to increase stocks as fast as possible. Gas companies are also concerned with contract renewals. In some instances an understanding has been arrived at, but in others there are points remaining to be adjusted. Slacks are firmly held, with a good inquiry coming from the Lancashire customers. Collieries have nothing to place on the open market. Householders still show great eagerness to secure stocking supplies as a safeguard against the prospective winter shortage. The export position for all grades does not contain many points of interest. Allied Powers manage to obtain their full requirements, but trade with neutrals is gradually declining. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.* per ton at the pit.

Iron and Steel.—The output of steel is once more assuming prodigious proportions, for both men and works seem to have settled down once more to the regular running that was so fine a feature of the Sheffield firms during the earlier part of the year. The recent holiday has exercised a beneficial effect upon all and sundry, and there are clear signs that the aftermath of the industrial trouble will not have a very injurious bearing upon munitioning the forces. In some cases definite offers of the men to work through the holidays were declined on account of the fact that in the particular line of munitions upon which they were engaged there was actually more than enough for a long time ahead. On the other hand, it is hoped by regular working and good timekeeping to overcome the evil which inevitably resulted in certain categories. More electric furnaces are being put down, for as time goes on the achievements of those already in use establish more and more firmly the utility of this type of steel melting, especially for the lighter qualities. The changes which have been made in the Sheffield works during the past twelve months, through the almost general adoption of the newer method, are indeed revolutionary, and when the time comes for their full effect to be recorded—that will be after the war—there will be some interesting, if not astounding, things to learn. File makers find that they are expected to continue their enormous output for the duration of the war, for there is no falling-off in the needs of the large armament firms of every description for files. Larger sizes that were being made in the early days of the war for Russia are not now being produced in such great quantities, but there is to-day a call for heavy deliveries of the sizes round about the 12-in. High-speed tool makers have important work on hand for the shipyards, particularly for the highest grade of tungsten steel products. Nothing further has been heard of the application of certain makers of high-speed steel for an increase in the allowances under the tariff of prices, and it is almost generally conceded here that nothing will be done in the matter now, whatever may happen in the more distant future. Saws are being produced on a large scale for both army and industrial purposes. The general overseas trade is of a satisfactory nature, with recent orders for engineers' tools, saws, files, spades, picks, sheep shears, wirework, hardware, butchers' knives, mining machinery, plane-irons, cutlery, plate, and steel.

Sir Robert Hadfield, Bart.—The honour of a baronetcy, which the King has conferred upon Sir Robert Hadfield, not only appears in the light of a well-earned reward to a distinguished and loyal son of the Empire, but also brings a reflected glory to the city of Sheffield. Sir Robert's own personal achievements are well known to engineers and metallurgists throughout the world. His discovery of manganese steel was an epoch-making invention. In 1899–1900 he was Master Cutler.

GERMAN TRANSPORT DIFFICULTIES.—According to *Stahl und Eisen* of January 18 last the Prussian State Railways have quite recently decreed that a certain proportion of goods trucks which have hitherto been labelled "for loads not to exceed 15 tons" are now to be employed for net loads of 17½ tons, in order to cope with the transport difficulties. The same German journal also states that from March 31 last no coal, coke or briquettes were allowed to be exported from Germany to Norway, Sweden or Denmark, *via* Lübeck, Kiel, Rostock, Stettin, Warnemünde and Wismar, the only exception being exports to the Danish blast-furnaces, *via* Dänischburg.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Notwithstanding the enormous output of steel in the West of Scotland makers find it difficult, with the means at their command, to meet the heavy demands made upon their resources. Government remains the most pressing customer, the orders for shell bars and mercantile material showing no signs of easing off, while the rapid pushing forward of the increasing shipbuilding programme throws an additional responsibility on the establishments supplying the steel required. Besides all this the needs of the Allies have to be considered also, but beyond this no other steel is being exported, the entire production being reserved for the great home demand. No change in price has taken place.

Malleable Iron Trade.—Malleable iron makers continue to report business conditions of the greatest activity in both their iron and steel departments, the bulk of the output going to meet the Government requirements, which are as heavy as ever. None of the steel produced, and very little of the iron, is available for export, hence overseas shipments are comparatively light, while the urgency of the Government requirements prevents any great quantity of material being freed for the ordinary home consumer. Prices show little or no change.

Scotch Pig-Iron Trade.—The production of pig-iron goes on apace, the demands of the iron and steel works being so constantly on the increase that a certain scarcity of some brands cannot well be avoided. So long as the present pressure for delivery continues it is doubtful if any licences for shipment would be granted. Steady prices still prevail.

New Crane for Greenock Harbour.—An interesting ceremony took place at Greenock Harbour a few days ago, when the new electric cantilever fitting-out crane erected at the James Watt Dock by Sir William Arrol and Company, Limited, for the Greenock Harbour Trust, was formally handed over, Provost McMillan accepting its custody on behalf of the Trust. As a memento of the occasion a handsome silver salver, the gift of the contractors, was presented to the Provost by Mr. Adam Hunter. At the final tests this new crane—designed to carry loads of from 80 tons to 150 tons—was found capable of working up to 200 tons.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Practically all the June allocations for the supply of Cleveland pig-iron to home users and customers in Scotland have now been issued, though a few belated allotments are still coming to hand. Though the allocations are on a very liberal scale, there is every reason to believe that they will be fully covered without difficulty. The blast-furnaces are working well generally, with the result that larger quantities of standard iron are available for distribution. Though forge iron is being taken up very freely, particularly for despatch to Scotland, makers have rather considerable stocks, and possibly purchases of this quality could be made at a shade below the fixed maximum, but the price has not been quotably lowered. A moderate export trade is passing. For home consumption No. 3 Cleveland pig-iron, No. 4 foundry, and No. 4 forge are all quoted 92*s.* 6*d.*, and No. 1 is 96*s.* 6*d.*; whilst for shipment to France and to Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.*

Stocks of Cleveland Pig-Iron.—Stocks of Cleveland pig-iron are small. The quantity held in the public warrant stores has now been reduced to 1,873 tons, all of which is No. 3 quality.

Hematite Iron.—There is no abatement in demand for East Coast hematite iron. The heavy home requirements are being adequately dealt with, and sales on home account are reported from time to time, but new export business is on a very limited scale, sellers still being reluctant to book foreign orders on the terms named. At the same time licences for despatch to our Allies are less difficult to obtain, and there is some improvement in shipments. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France, and 142*s.* 6*d.* for export to Italy.

Manufactured Iron and Steel.—Finished iron and steel prices are very stiff, and manufacturers are reported full of orders on behalf of the Government and for the shipyards. Producers are coping fairly well with the heavy pressure for delivery. The following are among the principal market quotations to home customers:—Common iron bars, 13*l.* 5*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; best best best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; packing iron and steel (parallel), 13*l.* 15*s.*; packing iron and steel (tapered), 15*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; steel hoops, 17*l.* 10*s.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

Ironworkers' Wages.—The accountants to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England have certified the average net selling price of iron plates, bars, and angles for the two months ended April 30 last at 13*l.* 9*s.*, as compared with 13*l.* 7*s.* 10.61*d.* for the previous two months, and in accordance with sliding-scale arrangements ironworkers' wages for June and July remain the same as prevailed during the preceding two months.

Shipments of Iron and Steel.—A marked and gratifying improvement is shown in the shipments return of iron and steel from the port of Middlesbrough during May, the total clearances being given at 93,230 tons, 59,915 tons being pig-iron, 1,501 tons manufactured iron, and 31,814 tons steel. The previous month the total shipments amounted to 57,529 tons, composed of 37,297 tons of pig-iron, 2,577 tons of manufactured iron, and 17,655 tons of steel.

Coke.—Coke continues in very good request for local use, and descriptions needed for the blast-furnaces are still realising fixed maximum rates, average kinds selling at 28*s.* at the ovens, and low phosphorus sorts at 30*s.* 6*d.* at the ovens.

THE NORTHERN OF FRANCE RAILWAY COMPANY.—We read in *La Métallurgie* that the Board of the Northern of France Railway Company have agreed to grant the request of M. Sartiaux, their general manager, to retire, and have conferred upon him the title of "Ingénieur en Chef Honoraire de l'Exploitation," as well as appointing him consulting engineer to the company.

THE ENFIELD RIFLE FOR UNITED STATES TROOPS.—It is stated in *The Iron Age* that the General Munitions Board announces that the use of the Enfield rifle by American troops raised for service abroad has been decided upon. This action had been contemplated for some time. A considerable number of plants in America have been making this rifle for the Allies and are, therefore, equipped with gauges, jigs, &c., for its production in very large quantities. It is understood that there are now nearly 1,000,000 of these rifles either completed or nearly so.

BRITISH CORPORATION FOR THE SURVEY AND REGISTRATION OF SHIPPING.—We have received from the secretary of this corporation a copy of the current issue of their "Rules for Classification and Construction," appended to which is a list of the vessels registered by the Corporation. The volume should be useful to shipbuilders and shipowners, as it contains the rules as revised and brought into force early in the present year. In a previous article, page 250 *ante*, we dealt specially with these rules, which are specially commendable for the assistance they render to those responsible for the design of ships. Consequently this volume may be accepted as a thoroughly modern text-book for use in the drawing office, as it deals in a commendably practical way with all questions affecting the strength and safety of ships. The rules are particularly lucid and are admirably arranged. There are also given tables of scantlings and equipment, and these are most complete. The corporation, which was founded in 1890, led the way to what might be termed, in the language of to-day, a "thoroughly democratic organisation." The committee of management or control is composed of shipowners, engineers, shipbuilders and representatives of underwriting and other associations. The funds of the society cannot become a source of profit to anyone. Moreover, no member of the committee of management can be present at or in any way influence the assignment of the load-line to, or the classification of, any ship in which he is interested directly or indirectly. As a result, the control ensures a consideration of all interests on a perfectly unbiased basis. Notwithstanding the restriction of merchant shipbuilding during the first two years of the war there is a gratifying increase in the number of vessels registered by the society, and of all of these ships full particulars are given in this volume. Those desirous of subscribing may communicate with the secretary, Mr. John Fleming, 121, St. Vincent-street, Glasgow.

THE BRITISH ENGINEERS' ASSOCIATION.—This association held a successful meeting at the Hotel Windsor on Wednesday last, the 6th inst., under the chairmanship of Mr. Wilfrid Stokes, the president. The primary object of the meeting was to adopt the revised memorandum and articles of association, as approved by the Board of Trade, which puts the seal on the amalgamation of the Manchester Engineers' Club movement for the organisation of the British engineering industry. The association, which has hitherto confined its membership to British manufacturing engineers, will now admit engineering departments of public services and also individuals. By this means the manufacturer, user and buyer, as well as the scientific expert, may be brought into the closest possible co-operation. District committees and trade sectional committees will be formed, with representation on the council of the association. An interesting discussion took place on the organisation of engineering education and research, and it was decided to appoint a committee to ascertain what is being done by the various bodies at present dealing with research questions and to see in what directions research work can be made of more practical utility to engineers. The need for the co-ordination of all the educational movements dealing with engineering matters and the desirability of formulating a very comprehensive scheme was urged. With regard to the operation of the association in China, the president stated that the committee had under consideration proposals of an extensive nature for undertaking general educational and pioneer work, with a view of bringing the advantages of the use of machinery to the notice of the undeveloped markets of that country. Further meetings would be held for the discussion of this scheme. In his remarks on the reconstruction question Mr. Stokes urged the importance of establishing more armonious relations with their workmen, a systematic exploitation of overseas markets, the importance of standardisation and co-operation in methods of production, and the difficulties of transport and shipping.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The beginning of this week witnessed a very firm undertone for all classes of coal on the Cardiff market. There was a heavy pressure of shipment on account of the allied Governments, and little or no coal was released for ordinary trading. The impending publication of the details of the new prices scheme also contributed to the strength of the position, and direct quotations of practically all the better qualities were ruling about 30*s.* Ordinary steams have been quoted between 27*s.* 6*d.* and 28*s.* 6*d.*, while Western Valley salesmen have been also asking this price for spot positions. Small coals, too, were relatively as firm as large, and best bunker qualities were quoted round about 17*s.*, and for good cargo descriptions 15*s.* At the middle of this week, however, there was again experienced something approaching a slump. The requirements of the authorities continue heavy, and requisitioned tonnage is arriving regularly enough to keep all the Admiralty list collieries fully employed. Some of the inferior sorts are practically unsaleable, and even good bunker qualities are now offering under 15*s.* Imported pitwood is firm at 75*s.*, while home-grown timber is steadily advancing in price, with current figures ruling up to 70*s.* and 72*s.* 6*d.* The other sections of the market remain featureless. The latest variations in the quotations are approximately as follow:—Second Admiraltie, 29*s.*; ordinary steams, 28*s.* 6*d.* to 29*s.* 6*d.*; Black Veins (Cardiff shipment), 28*s.* 6*d.* to 29*s.* 6*d.*; Western Valleys (Cardiff shipment), 28*s.* 6*d.* to 29*s.* 6*d.*; and best Eastern Valleys, 27*s.* 6*d.* to 28*s.* 6*d.* For best smalls the quotations were round about 14*s.* and 15*s.*, and for best ordinaries 13*s.* 6*d.* to 14*s.* 6*d.* In the bituminous section Black Veins ruled at about 28*s.* 6*d.* to 29*s.* 6*d.*; best Eastern Valleys, 27*s.* 6*d.* to 28*s.* 6*d.*; and best smalls, 14*s.* to 15*s.*

Newport.—A slightly easier undertone has pervaded the spot market for Monmouthshire coals this week. The proposed new minimum schedule, which approximates very closely to the market prices which have been current during the past few days, is proving a sufficient check against anything like the slump which took place a few weeks ago, but shippers with tonnage ready in dock have been able to obtain parcels slightly below yesterday's figures. Iron ore supplies are arriving steadily at their fixed prices, but in the pitwood market the Board of Trade restrictions are having their anticipated effects on home-grown prices, and the latter are now nearly on the same basis as that of imported wood. There is no change to note in the other sections of the market.

Classification of Welsh Coals.—As a result of the meeting of the South Wales and Monmouthshire coalowners, and the appointment of a committee to deal with the classification of coals, all the colliery offices at the Welsh docks have received this week, from the Statistical Department of the Coalowners' Association, forms in which the names of collieries have to be entered against the qualities of coal marketed on the Exchange. It will take some time to compile this information, and the task of filling in the particulars will, in many cases, involve delicate questions of differentiation. For the Cardiff and Swansea districts the following schedules of classes of coal have been drawn up:—Cardiff: *Steam.*—Best Admiralty large, best seconds, ordinaries, best drys, ordinary drys, best bunker smalls, best ordinaries, cargo smalls, inferiors, washed smalls, Black Vein (large), ordinary Western Valleys, best Eastern Valleys, second Eastern Valleys, best washed nuts, seconds, best washed peas and beans, and seconds. *Bituminous.*—Best households, good households, No. 3 Rhondda large, No 3 Rhondda through, No. 3 Rhondda smalls, No. 2 Rhondda large, No. 2 Rhondda through, and No. 2 Rhondda smalls. Swansea: *Anthracite.*—Best breaking large, seconds (ditto), third (ditto), Red Vein large, machine-made cobbles (bests), machine-made cobbles (seconds), machine-made cobbles (thirds), Red Vein cobbles, machine-broken nuts (French, Paris and stove), best, seconds and thirds, machine-broken beans (bests, seconds and thirds), screened cobbles, nuts and beans (third quality), peas (all qualities), rubbly culm, Red Vein culm, breaker duff, and billy duff. *Steam.*—Best large, seconds, bunkers (through), bunkers (smalls). The colliery companies are instructed to insert the name of each colliery separately against one or other of the above.

MILK BOTTLES OF PAPER PULP.—Not many years ago it was considered essential in the interests of health not to distribute milk any longer by the can and dipper method, but to serve it to customers in glass bottles. In America the glass bottle is now being replaced by a paper case which is only used once, because the cleaning of glass vessels is regarded as too difficult and unreliable. According to *The Scientific American* of March 17, 1917, one firm makes 5,000 paper-pulp bottles per hour. The wood pulp is used as such, and not first turned into paper. A steel core is dipped into a tank of raw pulp and the pulp is pressed on by four clamps, whilst the core is turned three times; a hollow pulp cylinder is thus formed, somewhat as if the material were clay. Before the dried cylinder is removed from the core, by means of a steel hand, the capacity of the bottle and the name of the firm, &c., are printed into the pulp. A belt conveyor then takes the cylinder to a machine which crimps on the bottom and top; the next step is impregnation of the pulp with fused paraffin to prevent contamination of the milk by the pulp; the paraffin is acid-proof. The bottle is then ready for delivery, the whole continuous operation of the conversion of the pulp into a finished bottle occupying 8 minutes.

SLOT-MILLING MACHINE FOR TURBO-GENERATORS.

CONSTRUCTED BY THE NEWTON MACHINE TOOL WORKS, INCORPORATED, PHILADELPHIA, U.S.A.

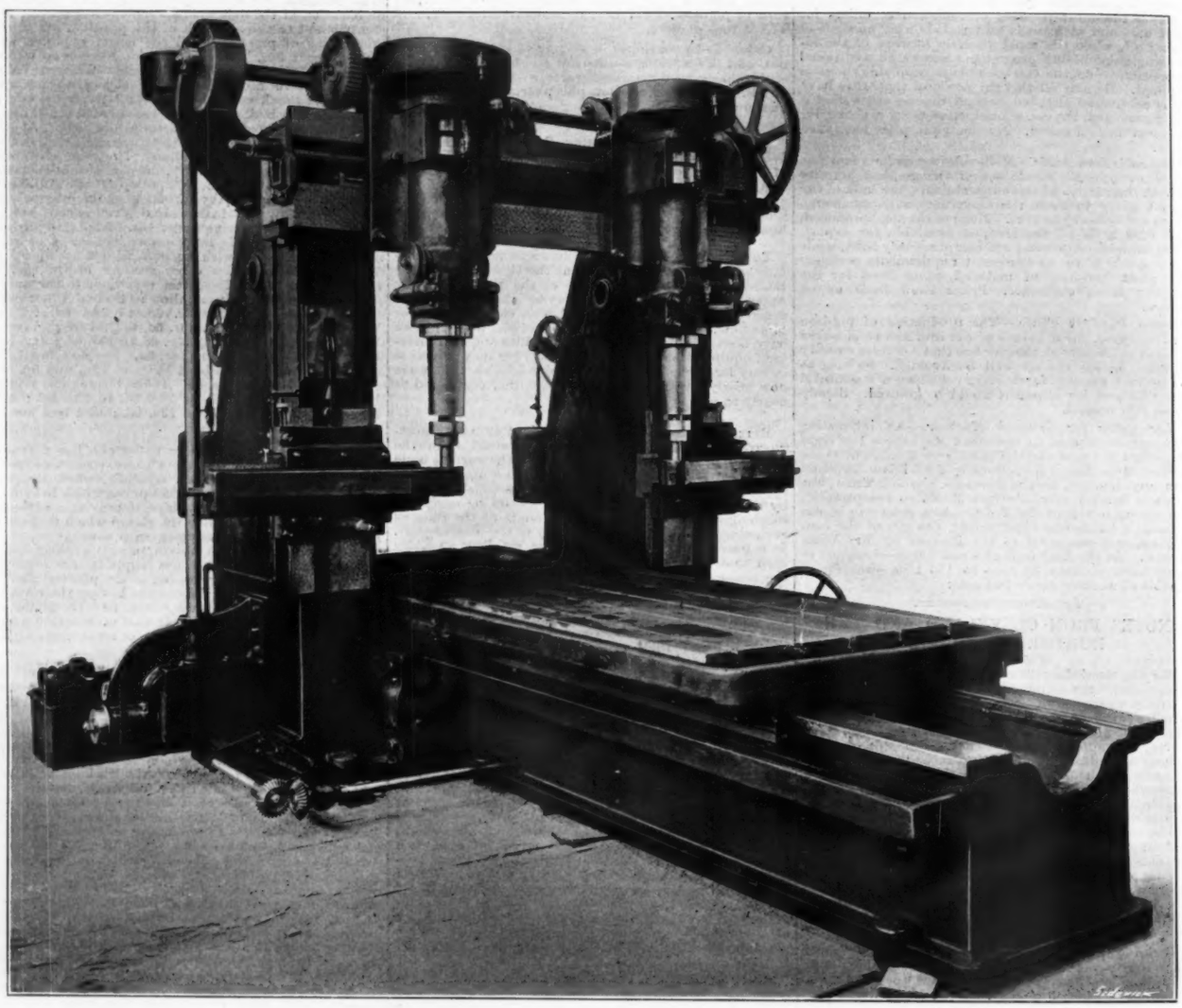


FIG. 1.

ON this page, and on Plates LIX and LX, we illustrate two machines built by the Newton Machine Tool Company, Inc., Philadelphia, U.S.A., for the General Electric Company, of Schenectady, and intended for slotting alternator rotors.

As Fig. 1 shows, the first machine is constructed on the lines of a planing machine, but the planer tools are replaced by two milling heads, the spindles of which are supported both at top and bottom. The rigidity thus secured enables very heavy cuts to be taken. The drive is transmitted to the spindles by worm gears, which are wholly enclosed in oil baths. The spindles are counterweighted and can be adjusted for height independently of each other. This adjustment is effected by hand through the intermediary of worm gearing. The cutters are secured on the spindles by through retaining bolts and fit over the broad face keys on the spindle. Counterweights are also provided for the saddle carrying the steady rest which takes the lower end of the spindle. The spindle end here is 3 in. in diameter and fits in a tapered bush, which can thus be adjusted for wear. Both horizontal and vertical adjustments are provided for this steady, so that accurate alignment with the upper bearings of the spindle presents no difficulty, as the cross traverse for the top carriage and for the lower one are geared together.

The table has square lock bearings with overlapping gibs, and has an angular rack with worm pinion drive. It is fitted with hand-adjustment gear, three changes of feed and a quick return gear. Automatic releasing gear is provided for each direction of travel. Control levers are provided in duplicate, one set at each side of the machine.

The table derives its motion from a variable speed electric motor, rated at 20 brake horse-power and capable of running at either 400 r.p.m. or 1,200 r.p.m. With the slow speed the table feeds per minute available are 0.222 in., 0.666 in. and 2 in., and treble these rates with the motor running at 1,200 r.p.m. The quick return is made at 20 ft. per minute. The milling spindles are driven by a separate motor of the same type—rated at 25 h.p. and capable of being run at either 500 r.p.m. or 1,000 r.p.m. The minimum spindle speed is 5 r.p.m., and the maximum is 20 r.p.m. The principal dimensions of this tool are as follow:—

Width of table over finished surface...	52 in.
Width of table over oil pan	59 in.
Width between uprights	62 in.
Length of table over all	16 ft. 6 in.
Maximum length of cut	15 ft.
Length of base over all	27 ft.
Distance from face of uprights to centre of spindles	14 in.
Height under cross rail	63 in.
Distance between spindles centres	Max. 75 in. Min. 25 in.
Distance, centre of saw blades to table	Max. 32 in. Min. 30 in.
Distance, end of spindles to table	Max. 37 in. Min. 35 in.
Diameter of spindle in driving worm-wheel sleeve	5½ in.

In Fig. 2, Plate LIX, the machine is shown in operation cutting the slots for the winding, whilst in Fig. 3 the slots on the coupling end are being milled. As delivered from this machine the winding slots are parallel. The lighter job of dovetailing them is effected on the second machine, which is illustrated in Figs. 4 and 5, Plate LX. Here, it will be seen, it is not the work that is traversed, but the tool, which, as shown in Fig. 5, is simply mounted on an adjustable table, which can be traversed over the bedplate of the machine. Two milling spindles are provided as indicated in Fig. 4. The head which carries them is mounted on an inclined slide so that it can be accurately adjusted for height. The machine is motor-driven, and an ample range of speeds and feeds is provided for.

DUTCH EAST INDIES STEAM COAL.—A telegram from Batavia, says *The London and China Telegraph*, reports that the squadron at Sourabaya has made a trial of the coal of the Boekit-Asem mine, in Palembang, with very much success. The quality of the coal is said to be equal to that of the Cardiff mines. These coalfields contain sufficient coal to supply the want for many years.

LEAD OUTPUT OF THE UNITED STATES IN 1916.—We read in *The Iron Age* that the production of primary refined lead in the United States in 1916 was 571,134 net tons, as against 550,050 net tons in 1915, an increase of 3.8 per cent. This is a record output. The primary lead available for consumption was 477,384 tons, an increase of 12 per cent. over the figures for 1915, which were 426,364 tons. This is also a record. The exports of domestic lead in 1916 were 100,565 tons, against 87,306 tons in 1915 and 58,722 tons in 1914.

THE RECONSTRUCTION OF THE UNION PACIFIC RAILROAD BRIDGE AT OMAHA.

(*For Description, see Page 537.*)

FIG. 1. THE NEW SPANS IN POSITION.

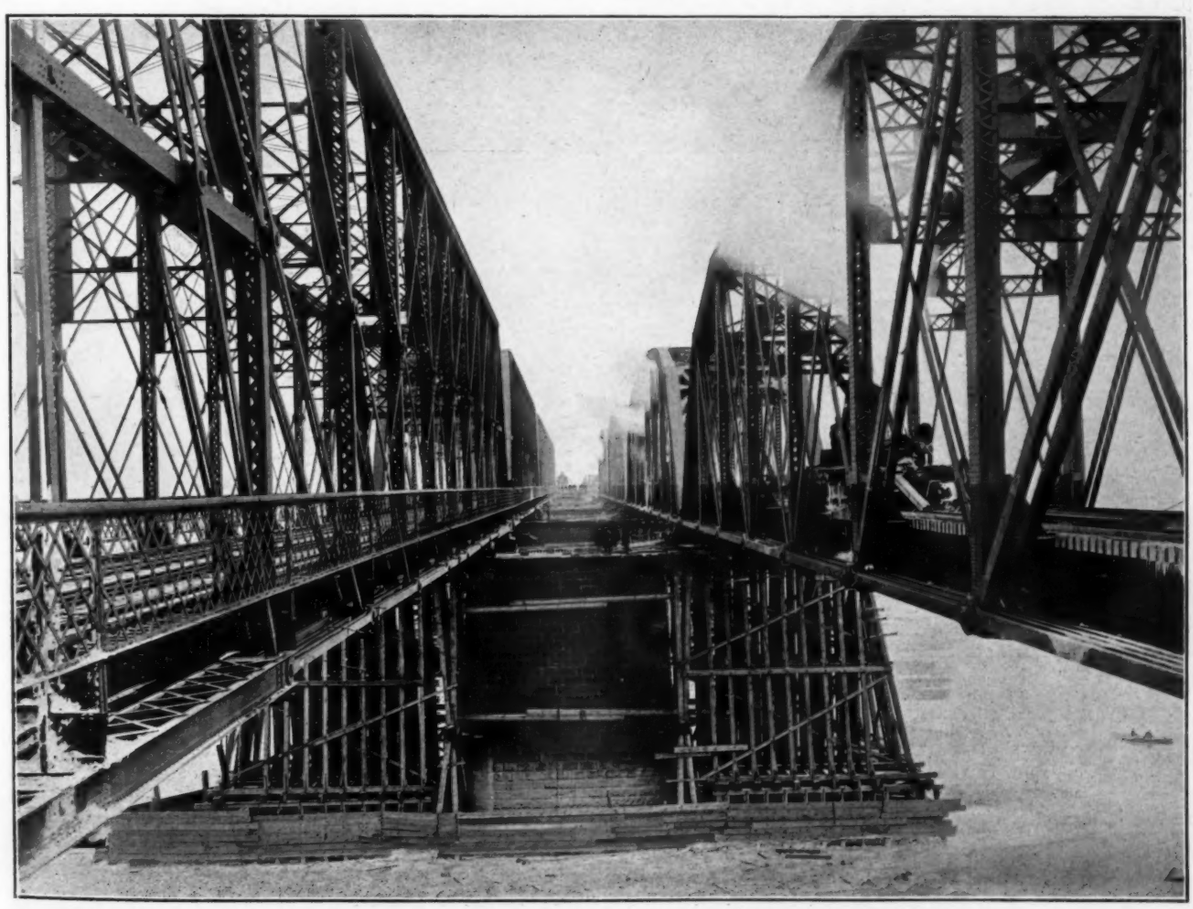


FIG. 2. OLD SPANS REMOVED AND NEW SPANS AWAITING TRANSFER TO OLD PIERS.

THE RECONSTRUCTION OF THE UNION PACIFIC RAILROAD BRIDGE AT OMAHA.

(For Description, see Page 537.)

FIG. 3. NEW BRIDGE IN POSITION; OLD BRIDGE AWAITING DISMANTLING.

FIG. 4.

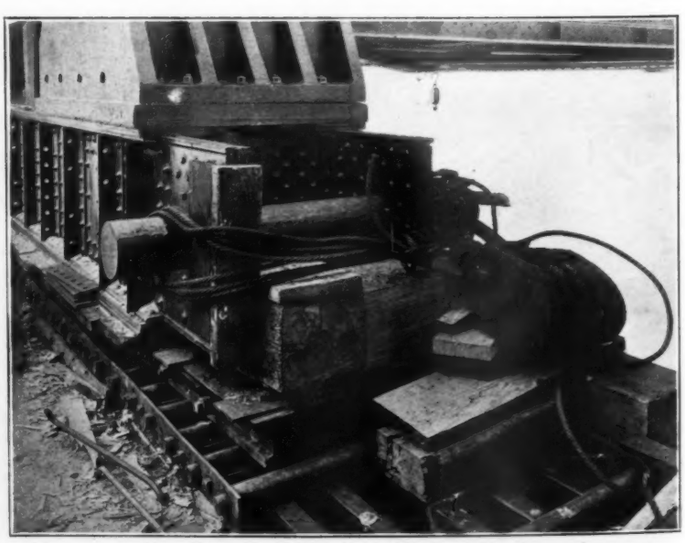


FIG. 5.

FIGS. 4 AND 5. ROLLER-WAYS FOR TRANSFER OF BRIDGES.

(To face page 537.)

SLOT-MILLING MACHINE FOR TURBO-GENERATORS.

CONSTRUCTED BY THE NEWTON MACHINE TOOL WORKS, INCORPORATED, PHILADELPHIA, U.S.A.

(*For Description, see Page* 546.)

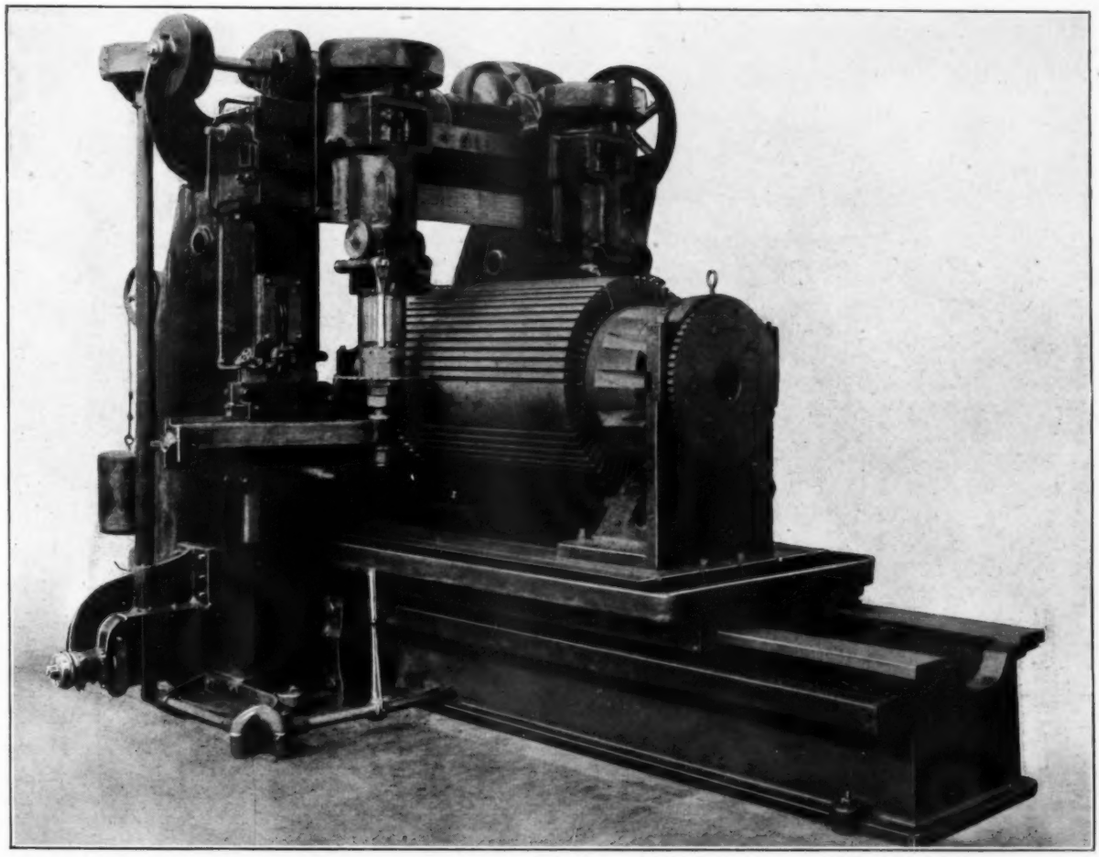


FIG. 2.

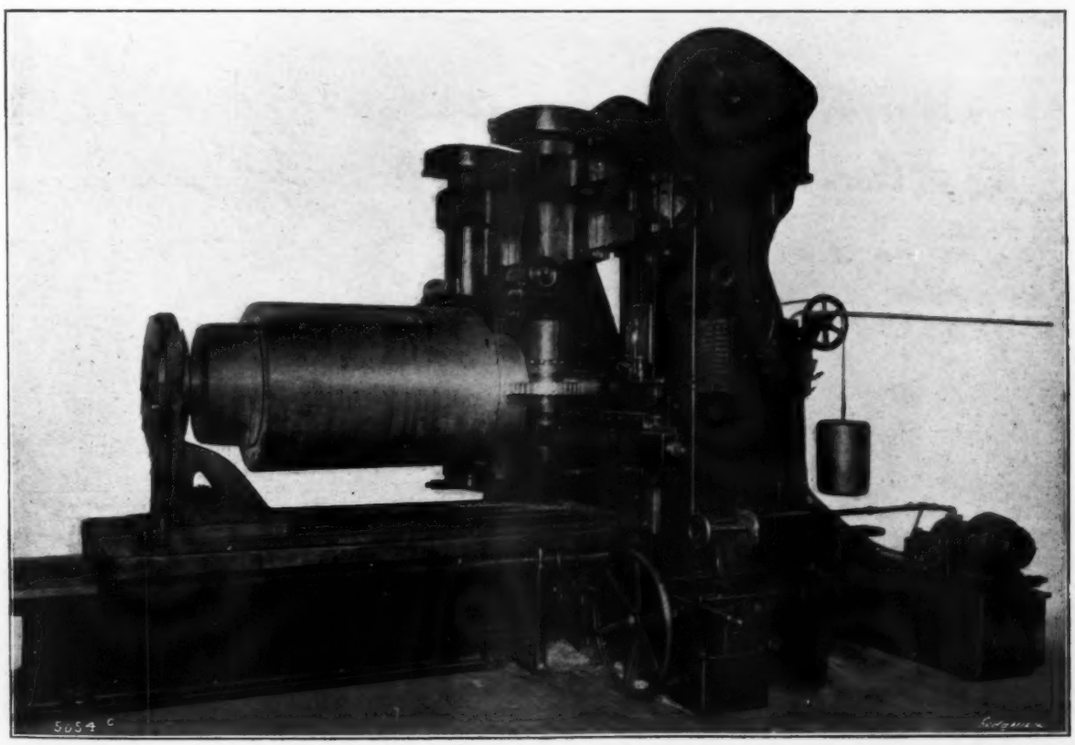


FIG. 3.

(*To face page* 546.)

MACHINE FOR CUTTING DOVETAILS ON ARMATURE WINDING SLOTS.

CONSTRUCTED BY THE NEWTON MACHINE TOOL WORKS, INCORPORATED, PHILADELPHIA, U.S.A.

(*For Description, see Page* 546.)

FIG. 4.

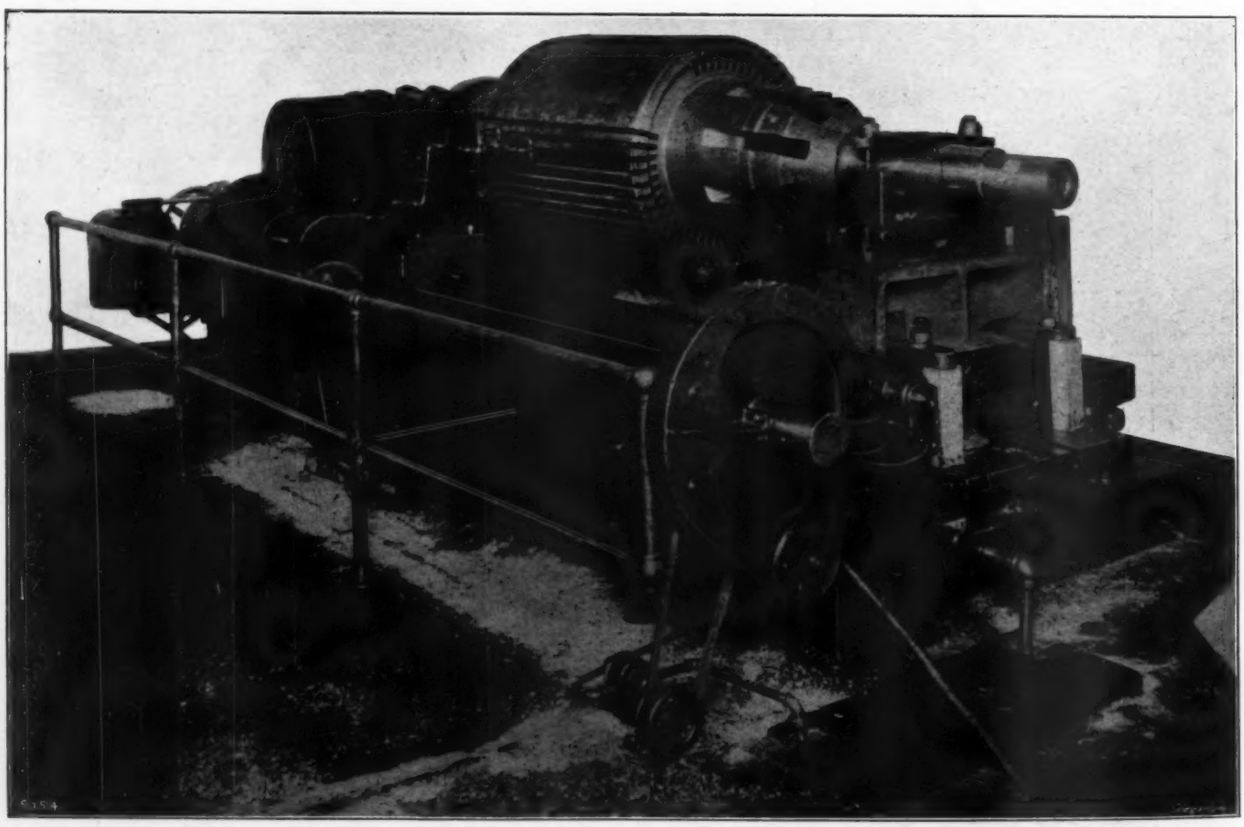


FIG. 5.

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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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With Two One-Page Plates of the RECONSTRUCTION OF UNION PACIFIC RAILROAD BRIDGE AT OMAHA, and Two One-Page Plates of SLOT-MILLING MACHINES FOR TURBO-GENERATORS.

NOTICES OF MEETINGS.

THE PHYSICAL SOCIETY OF LONDON.—Friday, June 8, at 5 p.m., at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W. Agenda:—(1) "A Bridge Method of Comparing Fixed Inductances," by Mr. T. Parnell, M.A. (2) "The Radiation from Loaded Antennæ," by Mr. Van der Pol. (3) "A Demonstration of a Method of Preventing Sparking at a Rapid 'Make and Break'" will be given by Dr. A. Griffiths.
THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS (INCORPORATED).—Wednesday, June 13, at 2.30 p.m., at the Midland Grand Hotel, St. Pancras, when Mr. Ellison will reply to the discussion on his paper "Automatic Signalling;" afterwards, if time permits, Mr. Griffiths will read a paper on "Some Impressions of Continental Signalling Practice."
THE INSTITUTION OF MINING ENGINEERS.—Friday, June 15, at 11 a.m., in the Rooms of the Geological Society, Burlington House, Piccadilly, London, W. 1. The following papers will be read or taken as read:—(1) "The Spontaneous Firing of Coal," by Dr. John Scott Haldane, M.D., F.R.S. (2) "The By-product Coking Process, its History, Development and Application," by Mr. Ernest Bury. (3) "Acetylene Mine Lamps," by Mr. William Maurice. The following papers, which have already appeared in the Transactions, will be open for discussion:—(a) "The Permeability of Coal to Air or Gas, and the Solubilities of Different Gases in Coal," by Mr. J. Ivon Graham. (b) "The Absorption of Oxygen by Coal (Part X): the Formation of Water in the Oxidation of Coal," by Mr. J. Ivon Graham. (c) "The Form and Structure of the Coalfields of Scotland," by Mr. David Ferguson.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

ENGINEERING.

FRIDAY, JUNE 8, 1917.

CARRYING ON THE NATION'S INDUSTRIES.

A DECISION has shortly to be taken on the immediate future of the staple industries that are not producing munitions; whether and how they are to be carried on for the remainder of the war. To the entire community the question is of urgent importance, both in itself and in the principles on which the answer turns; but it has a special and further interest to those engineers who are working as mechanics. The facts cannot be stated too plainly while there is yet time for the right decision to be reached.

Years have passed away, and much more, since we were told to carry on "business as usual." We can no longer do so. The generous armies who were to end the war had to await the supply of weapons; their men fell in this delay, while the enemy's defences grew stronger; and now, like the enemy and our Allies, we want for military service every fit man whose work in his civil employment can be foregone or replaced. Fit men are to be found in every one of the "protected" occupations; and military necessity now requires these men to be withdrawn for service, either in the army, as all such men in other occupations have already been withdrawn, or in munition works. If the industries from which they are taken are to be continued, the places of these men must be filled. The welfare of the nation requires of all staple industries that business, if it can no longer be carried on as usual, shall at least be carried on. The products of some of these industries even now are necessary for daily life; and when the war is over the commerce of all of them will be needed as it has never been needed before. Each one will have to do its part in finding employment for the soldiers who return, and in earning the living by which the nation will exist and pay its way. The less completely we win the war, the longer we take in winning it, and the more we neglect our staple trades while it lasts, the harder will be the struggle when the war is over; the less work will there be, the less earnings, the less pay. To maintain these trades is, in fact, an inseparable part of the whole war problem; and, no less than the rest of that problem, its solution requires above all other considerations that the needs of the army should be satisfied without reserve.

The Ministry of Munitions, through the labours of its technical staff, has shown how these trades can be maintained, and how at the same time they can be helped to produce munitions as well as to provide men for military service. Not in one art alone, but in a variety so great that it covers practically the whole field of industry, it has demonstrated that the employment of women can supply rank-and-file mechanical labour to an extent far beyond what was ever thought possible; and for the provision of the necessary men with all-round experience and skill it has initiated a sort of "general post," by which men can be transferred from where they can be spared to where they are wanted. The system has been working long enough and on a large enough scale to leave no doubt of its technical efficiency; and it offers a means, which at the present time is the only possible means, by which engineering industries not producing munitions can both keep themselves on foot and release the men who are wanted for munition factories and for military service.

A Bill has accordingly been introduced for extending to these industries the liberty that at least in law, if not in unrestricted practice, has already been given to the munitions industries. Such extension is merely the administrative consequence of the facts summarised above; and until it is made and acted on, either the military services or essential industries will go short of men. The munitions industries themselves are directly and considerably interested in the proposal. The provisions of the Bill are wanted not only for releasing skilled men for military purposes without stopping the trades in which they have been working, but also, and perhaps still more, for transferring skilled men from non-munition to munition shops. It is understood, however, that various bodies of workmen have taken objection to the Bill, which, with other alleged grievances, is the subject of negotiations now in progress between the Government and certain trade unions. The strikes that have constituted the chief German successes of the past few weeks have abated for the moment; but the negotiations on the new Bill are being conducted under the express threat that engineers in important centres will again "withdraw their labour" if the proposals for further dilution are not dropped.

All these matters, including the existence of grievances among the men concerned, are of grave consequence. The Government is bound beyond question to consider, as it is doing, what these grievances are, and through what causes, internal or external to the trades, they have resulted in industrial dispute. The present conditions of employment are without precedent. Many men may have the fear that the increased use of women to help in carrying on will make things worse after the war; and although this is the exact contrary of the truth, and whatever extra help women can now give in industry will not only save men's lives but preserve their means of living, the mistake is easily made, and must often warp the judgment of those who make it. Although, again, engineers on the whole have been very free from financial distress, it is easy to believe that hardships may have arisen. New regulations may not have been explained as promptly or as clearly as they might have been; delays may have occurred in dealing with grievances; these delays may have bred in men a sense of injustice, and sometimes have produced substantial hardship. If this be true, of any of it or anything like it, all possible measures of redress that are legitimate would command the sympathy of everyone engaged or interested in the industries concerned. But however true it may be, the sum total of what men may be wrongfully compelled to endure is not to be compared with the sacrifices that our soldiers are making every day; and Parliament, if it entertained such hardships as a ground for relaxing or tampering with any measure that would increase either the strength of our forces, or the abundance of their munitions, or the prospects of their employment when they return to civil life, would quite literally be deserting its soldiers in the face of the enemy.

No sum, in fact, of quantities having an

intrinsically lower order of magnitude can sensibly affect the country's supreme obligation to its forces. When that is in question, even the nation's interests concur with its honour in shutting out matters of less importance. And yet another consideration has to be remembered, less cogent indeed than the State's duty to its fighting men, but higher in importance than the duty of remedying the grievances of a single class; the democratic duty of treating all classes alike, which is expressly challenged by the engineers who dissent from the present Bill. Their claim is that they are entitled to be exempt from transfer to the production of munitions or to military service if their places would be filled by women or by men classed as unskilled. It is a claim that an engineer has no more title to make than a clerk, a peer, or a labourer; and even less ought it to be entertained by a Government which must, or should, have as much concern for the inarticulate majority of workers without a common professional bond as it has for the articulate minority which negotiates with it through trade unions. Whatever precautions can be taken to assure men their jobs when they return ought to be taken, however superfluous they may be in their application to decent employers; but an engineer cannot justly or democratically be exempted from military service, nor honourably accept exemption when another man would not get it, unless it is impossible to replace him in other work of present necessity to the country. To apply any other test would be at once to distinguish unfairly between man and man, and to diminish the efficiency of the country's man-power.

Those who have worked with British mechanics and are familiar with them in private life know that individually they have a strong fellow-feeling for their comrades; that a cheerful willingness to serve each other when there is trouble about is an essential part of their civilisation; that they have a straight enough eye for fair play, and in matters of any consequence are as apt as any men to give it without asking, when they are left to themselves. That any substantial body of such men could, of their own accord, and with a real conception of what they are doing, have adopted the attitude that they are now taking towards the interests of their comrades at the front, is unthinkable; and no inquiry could be of more general interest than any that would throw light on the influences by which these men have been misled. But for the time being such inquiry is less urgent than the practical decision that is now in question. For the present purpose it is enough to assume in the men's favour that their conduct is not the result of their spontaneous verdict on fully understood facts; that no natural influence can have led them with their eyes open to the unnatural threat by which they have sought to strengthen their claim.

The threat in plain language is that, if Parliament insists on making the best use of our man-power and our woman-power in the interests both of its armed forces and of the entire nation, these men will adopt the very attitude that the Prussian Government most wishes them to take up; that by ceasing work they will give the enemy the utmost aid and comfort that is in their power. It is a threat of treason, used for the purpose of blackmail. While it remains, it dishonours alike those who make it and those, if there be any, who are taking it into serious account. When the war is over, if no better way can be found for securing men their rights, let them again take to striking. While the war is on, the country cannot afford strikes. Engineers who wish to serve in civil life, and are wanted there, will do their duty if they work where they are wanted, and work their best. Those who will not discharge this duty must share with other men the obligation to serve in the army. A Government that allowed them to do neither the one nor the other, a Parliament that sanctioned such a licence, would have to answer to the Empire that its weakness was jeopardising, and to the men and women whose nearest kindred would be its immediate victims.

These are the simple and unalterable facts that govern the situation, and those who lead or advise engineers would do well to realise them; for when the new constitution of industry comes to be framed, the claim of those leaders and advisers to the place in it that they ought to be able to fill will be fatally compromised if it is found that their influence has not stopped engineers from betraying their friends and helping the enemy. In the interest of the men themselves, no less than that of the country, we deprecate their remaining in a false position, and should regard any action of Parliament that permitted them to do so as a national misfortune.

The language that we have used is no stronger than is necessary to express the truth. Some of it may apply equally to men in other protected occupations; but our own concern is with engineers, to whom, in conclusion, we may commend the message that was published recently: "Every hour we work, we may save lives dear to us. Every hour of idleness may mean murder." If this epitome of the situation is true of men who are working in munition shops, it is at least not less true of men who should be there or in the ranks. We quote this literal and unexaggerated statement because it comes from men who know well both what has been done and what is now proposed. By no one could such a declaration of the real nature of these grave matters be made more appropriately or with more conclusive effect. For the words quoted are taken from the greeting and admonition sent to Russian workmen by the shop stewards of Woolwich Arsenal.

COMMERCIAL AERONAUTICS.

ALTHOUGH at the present moment we are chiefly concerned with the military uses of aeroplanes, the time is nevertheless opportune for the consideration of the commercial possibilities of aerial transport. At the conclusion of the war the number of pilots, mechanics and machines, and the enormous manufacturing organisation recently built up, will be far greater than is necessary to supply the peace-time requirements of the Army and Navy, so the surplus will then be available for employment in any enterprises that give promise of financial success, as well as for purposes of sufficient national importance to justify subsidies by the State. Although it is certain that aeroplanes will never seriously compete with railway or road transport for heavy or bulky goods, it must be admitted that many of the objections formerly raised to their employment for more suitable work have been wholly, or partially, removed by the experience gained during the war. Flying is possible in almost any weather nowadays, and the comparatively few accidents which now occur are due, more often than not, to some acrobatic manœuvre on the part of the pilot that would be quite unnecessary in the course of an ordinary journey. Machines now in existence are capable of carrying loads of a few tons at speeds nearly twice as great as that of an express train, and such machines could easily be designed with comfortable cabins for the conveyance of passengers. If, then, it is admitted that the technical and natural problems involved are either solved, or capable of solution, the most important point to be decided is whether the advantages of aerial transport over other means of conveyance are likely to outweigh the extra cost of the former.

Mr. G. Holt Thomas, lecturing on this subject at a recent meeting of the Aeronautical Society, gave some interesting figures of the estimated costs of conveying passengers and mails between London and Paris and other cities. These figures, which, considering Mr. Thomas's long connection with the commercial side of aviation, should be fairly reliable, show that the total cost of running one machine each way daily between London and Paris would be 4*s.* 8*d.* per mile, this amount including interest on capital, running expenses, labour, overhead charges, and a reasonable allowance for depreciation and repairs. If four machines were run each way daily, the total cost would be reduced to 3*s.* per mile, and as each machine would be capable of carrying 12 passengers, a handsome profit could be obtained by charging each passenger 5*l.* per trip. The journey would take only three hours instead of seven, so that it seems not unreasonable to suppose that the service would eventually attract a sufficiently large amount of traffic to enable the machines to run each trip with a full complement of passengers. This is important, because the profit would disappear if the number of passengers per trip were reduced to nine, and a smaller number would result in a loss. To enable a service to be started some form of subsidy or a guarantee against loss would, therefore, be necessary. In the conveyance of mails it appears, from Mr. Holt Thomas's figures, that aerial transport can compete with existing methods even in the matter of cost, since a 1-oz. letter could be profitably carried between London and Paris for ½*d.*, and a 3-lb. parcel for 2*s.*, but these figures are also based on the assumption that a full load is carried on each trip. Passengers and mails could be carried between London and Marseilles in 8 hours, instead of 23 as at present, and the charges would be 10*l.* for passengers and 1*d.* per ounce for letters. Constantinople or Moscow could be reached in 20 hours, the charges for passengers and mails being 25*l.* and 2½*d.* per ounce respectively. These times, it may be mentioned, are based on the comparatively moderate speed of 80 miles per hour.

For such services, Mr. Holt Thomas considers it necessary to avoid the inconvenience, or danger, of forced landings by establishing landing grounds along the whole route, spaced not more than 10 miles apart; and, at first sight, this certainly seems to be a stupendous undertaking. These landing grounds, however, are not fully equipped aerodromes, but are simply reasonably level fields provided with telephones, some having sheds for aeroplanes, and others having searchlights to act as guides in night flying. The average cost of hiring and maintaining each of these landing grounds is taken as 250*l.* per annum, and, at this figure, they would not increase the cost of working by more than 2*d.* per mile on the London-Paris route, with four machines running each way daily. For long-distance flights over the sea Mr. Thomas suggests the use of small ships stationed about 50 miles apart all along the route to act as guides and to render assistance in case of accidents. Considerable attention will certainly have to be given to this part of the scheme, but the difficulties involved are probably not insuperable. Mr. Thomas proposes that all the principal cities of the world should be linked up in this way, and although the scheme is certainly too far-reaching for immediate adoption in its entirety, if a start could be made the experience gained would doubtless lead to extensions.

The main advantage of aerial transport is, of course, its speed, and the importance of this, from a commercial point of view, must be admitted by all. It has, however, several additional advantages which render it especially suitable for opening-up new country before the construction of roads and railways. Aeroplanes can travel in a straight line over large tracts of desert country, and over country in which the cost of railway construction would be quite prohibitive if the construction were possible at all. An aerial service in such cases, Mr. Thomas states, could be inaugurated at a capital cost of 60,000*l.* for a 100-mile route, whereas the average capital expenditure on single-rail railway construction in various countries may be taken as 1,000,000*l.* for the same distance. The railway would, of course, carry vastly more traffic than the aerial service, so that railways would doubtless be constructed as soon as the country was sufficiently developed to justify the expenditure.

The recent achievements of military aircraft must certainly have done much to modify the generally apathetic attitude of public opinion towards this branch of aviation, so that it is not unlikely that commercial aviation will meet with a more sympathetic reception. This would certainly be the case if the impression created by the early difficulties of flying can be removed. In any case it must be remembered that all other forms of transport were very far from perfect at their inception, and although aerial transport will probably be no exception to this rule, some, at least, of the objections raised are more imaginary than real. Difficulties will certainly be encountered, but there is no reason to suppose that they will prove insuperable. Government-subsidised mail services having the right to carry passengers, as suggested by Mr. Thomas, seem quite feasible, and subsidies would, of course, be required for development work overseas. In this connection it is hardly necessary to point out that in some future war a country having a large number of well-developed commercial air services would be

in an immensely superior position to one in which attention had been given to the military and naval side of aviation only.

We may mention in conclusion that Lord Cowdray, the President of the Air Board, has appointed a committee, under the chairmanship of Lord Northcliffe, to advise on the uses and development of commercial aircraft. This report should be of considerable interest and importance to the nation at large as well as to the British aircraft industry.

THE ELECTRICAL PROPERTIES OF GASES.

IN opening, on Saturday last, the fifth lecture of his course on the above subject, at the Royal Institution, Sir J. J. Thomson, O.M., P.R.S., recalled that on the last occasion he had discussed the relationship between the potential required to produce a spark and the width of the gap and the pressure of the intervening gas. He had pointed out that this potential depended solely on the quantity of gas present between the electrodes, so that so long as the product of the gaseous pressure and the width of the gap was constant the potential needed to produce a spark was also constant. It was a matter of indifference whether the length of the spark gap was small and the pressure great or the distance large and the pressure small. Hence, whilst in general the potential needed increased with the length of the spark, there was nevertheless a limit beyond which it was (with the gas at constant pressure) more difficult to get a short spark than a long one, and with very short gaps it became almost impossible to get a discharge at all. He proposed, on the present occasion, to explain some principles on which this peculiarity of the spark discharge might have been foreseen.

Consider, he continued, what was the condition essential for electricity to pass through a gas. This, as he had pointed out in a previous lecture, was a supply of negative and positive particles derived from the gas itself. By the action of rays of various kinds such particles could be liberated in a gas, but in the case now under consideration the gas, in order to conduct electricity, must manage to produce these ions for itself without the aid of some external agent. This the gas was able to do with the help of such a residue of negative particles as might naturally exist in the gas. Thus any such negative particle in the gas would, under the influence of the electric field, acquire velocity and energy. It would, moreover, sooner or later collide with a molecule of the gas, and if the energy it had acquired exceeded a certain limit the shock of the collision would split up the molecule into positive and negative ions. Being still under the influence of the field the original negative particle would again acquire velocity and energy sufficient to split up another molecule of the gas, and at the same time the negative particle it had liberated from the first molecule it encountered would act like its parent, and also acquire sufficient energy from the field to split up any molecule it met. The original negative particle in this way continually "bred" new negative particles on its course through the gas. In some cases it did this at a uniform rate, and each negative particle liberated at each encounter would act similarly, so that the number of these particles increased according to the compound interest law. Hence if A_0 denoted the number of particles originally present and a unity plus "the rate of interest," the number present after the lapse of the time t was given by the formula $A = A_0 e^{at}$. The rate at which these negative particles increased was, therefore, very great.

Something more than this was, however, needed to maintain the conductivity of the gas and to make the discharge self-sustaining. Under the influence of the field all the negative particles would gradually be swept away from the cathode, leaving nothing there to make the gas conductive by fresh ionisation. Hence other means of ionisation were necessary. This agent need not, however, be a powerful one in comparison with the negative particle. Thus suppose that each negative particle produced a new negative particle for each millimetre of its travel along the field. In a traverse of 3 mm. each would, by the formula already given, have raised its progeny to e^3, or, in round numbers, to 20. In 6 mm. the number would be $20 \times 20 = 400$, and in 15 mm. the number would be over 3,000,000. Each of these 3,000,000 negative particles would be accompanied by its corresponding positive ion. But to keep the system going it was only necessary to replace the single original negative particle, or, in other words, the 3,000,000 positive particles were only called upon to ionise one molecule of the gas. The discharge would, accordingly, be self-sustained even if the chance of ionisation being effected at a single encounter between a molecule and a positive particle was almost infinitesimal.

Small as was the demand made, however, it had to be satisfied, but it need not necessarily be met by ionising action on the part of the positive particles. He was, Sir Joseph Thomson continued, by no means sure that the part played by these positive ions had not been overrated, and that the maintenance of the discharge might not quite possibly be due to radiation resulting from the impacts of the negative particles producing a sort of Röntgen radiation, part of which would strike back to the neighbourhood of the cathode. He thought the effect of this radiation had been somewhat overlooked in considering the mechanism of the discharge. Whatever the mechanism in action, it need only be feeble, since millions of agents were available. Hence from the practical standpoint the discharge might be considered as due to the fact that the negative particles were able to ionise the gas. Theoretically the positive ions came in, but so many of these were produced that they must be extraordinarily incapable if between them they were not able to produce the single negative particle required. If a traverse of 15 mm. gave 3,000,000 positive particles, one of 30 mm. would yield the square of this number, or 9×10^{12}. Hence, whenever there was so much gas between the electrodes that collisions were frequent, the criterion for a continuous discharge was that the negative particles should be able to ionise this gas. The condition might be expressed in the following fashion. Let X denote the electric force and λ the average distance between successive collisions of a negative particle with a molecule. At each collision it might be taken that the whole of the previous history of the negative particle was wiped out, and it had to start anew acquiring energy. Hence the distance λ between successive collisions must be such that the force X had time to give the particle the energy Q required to ionise the molecule. Hence

$$X = \frac{Q}{\lambda}$$

If V denoted the potential difference between the electrodes and d the distance between them, we had $V = X d$.

Moreover, λ, the distance between successive encounters, was inversely proportional to the pressure of the gas, so that

$$V = \frac{Q d}{\lambda}$$

$$\text{or} \quad V \propto Q d p$$

and was therefore constant when $p d$ was constant.

He had shown how easy it was to get up into millions of ionising collisions. Conversely, by halving the pressure or the distance between the electrodes, the number of ions produced might be reduced from a million to a thousand. On again halving the pressure or the distance, the number would fall to a little over thirty. Halving again would reduce the number to less than six. In that case the task set the positive particles of producing the single negative ion was very different from what it was when there were millions of them available for the job. To get a discharge in such conditions it might be necessary to increase X, the electric force, to quite abnormal values before a self-sustaining discharge could be realised.

By still further reductions of the pressure the collisions with the molecules might be so few that but one negative particle out of a thousand would ionise a molecule and produce a positive particle. To maintain the flow in such case, this single positive particle would have to produce 1,000 negative ones in order to keep up the supply. Hence a stage must be reached when the discharge would fail—too few positive particles being produced to maintain the necessary supply of negative ones. It was easy to see, therefore, that at very high vacua a high potential difference would be required.

Similarly, if the pressure were high, the path λ between successive collisions became very short, and a high potential difference would again be necessary to produce a discharge. It followed, therefore, that the graph representing the voltage necessary to maintain a spark at different pressures would have the general form indicated in Fig. 1, and that at some point this potential would have a minimum value. In the case of air this minimum value was, roughly, 300 volts, and the product $P d$ corresponding to this minimum potential was approximately 7, when P was measured in millimetres of mercury and the distance d was expressed in millimetres. At this minimum potential the distance between the electrodes was about fifteen

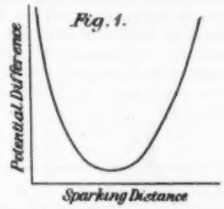


Fig. 1.

times the mean free path of the molecules, so that when the discharge was passing very freely a negative particle would have about fifteen collisions in passing from one electrode to the other. These collisions might be associated with the production of a sort of Röntgen radiation instrumental in producing the additional ionisation, which was necessary to maintain a steady discharge.

Ordinary cathode rays, the lecturer continued, caused glass to phosphoresce, and so did the radiation to which he referred. This new radiation, however, caused glass to phosphoresce a dark olive-green colour, quite distinct from the yellowish-green phosphorescence produced by the cathode rays. The new radiation could, moreover, be refracted through white fluorite, and was no doubt a form of light well up in the Schumann region of the spectrum. It had very great powers of ionisation, and the speaker thought it quite possible that the additional ionisation required to maintain the discharge was produced by this soft type of Röntgen radiation.

It might, Sir Joseph Thomson continued, be noted that luminous radiation might also be produced by the impact of negative particles with the molecules of the gas in a discharge tube. This the speaker demonstrated with a tube in which the cathode was a hot filament of wire supporting a speck of lime, which, in these conditions, emitted a large quantity of negative particles. These acquired velocity in passing through the electric field which was established between the two electrodes of the tube, and the energy given them could be varied by altering the potential difference between these two electrodes. The lecturer showed that with 40 volts difference of potential the gas in the tube was not rendered luminous by its collisions with the cathode particles, but that with 80 volts the luminosity was quite distinct. The change, he said, took place quite abruptly on the attainment of a certain definite voltage, which was that at which the moving particles acquired sufficient energy to ionise the gas.

The visible radiation thus produced had, however, itself no power to ionise the gas, but with higher voltages the soft Röntgen radiation referred to above was also emitted, and this was able to produce ions, an effect which had not hitherto been taken into account.

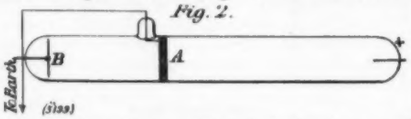
The ordinary kind of discharge could, he proceeded, be explained if the field were of uniform strength from electrode to electrode, and the graph representing the electric force at each point was then a straight line parallel to the base. There were, however, cases in which the electric force was not uniform throughout the tube, and in that case the appearance of the discharge was also not uniform. This effect was observed over a certain range of pressures only, and with certain gases. At fairly high pressures the luminosity of the positive column was uniform from end to end. If, however, the pressure were continuously lowered a stage was

ultimately reached when the column broke up into a series of detached portions of luminosity, separated from each other by dark spaces. If, however, the pressure were still further lowered these striations disappeared and the luminosity became uniform again.

This the lecturer demonstrated with a discharge tube in which the pressure was varied by absorbing the residual gases with charcoal cooled in liquid air. The effect was, the lecturer showed, also dependent on the diameter of the tube, so that with a tube consisting of a wide and narrow portion in series with each other the striæ were much closer together and more difficult to produce in the narrow portion than in the wide.

Sir J. J. Thomson next showed what was, he stated, a somewhat paradoxical experiment, in which the complete phenomena of the discharge in a vacuum tube were obtained with no difference of potential between the electrodes. The apparatus used is represented in Fig. 2. It consisted of

Fig. 2.



a long tube with a positive electrode at one end' as indicated; whilst there was a cathode at A with a hole in it and a third electrode at B. The two terminals A and B were connected together by a wire, which was earthed. Hence both A and B were at the same potential. On establishing a discharge between A and the positive electrode, however, the whole of the phenomena of the discharge were repeated in the left-hand extension of the tube between A and B. There were the negative glows, the dark spaces and the positive column, which showed striations. This result was obtained although A and B were at the same potential. The effect originated, the lecturer said, in the passage of positive particles through the hole in A, and he showed that it disappeared entirely if the direction of the current was reversed. The electric force averaged over the space between A and B was zero. At some points in the interval it was opposed to the current, whilst at others it favoured it.

This experiment served, he said, to emphasise a most important point. In dealing with a discharge at low pressures we had not to deal so much with the value of the force at a particular point as with its average value over a considerable distance comparable with the mean free path of the particles. In order to produce ionisation the particles must have acquired a certain velocity, and if the path were very short, so that the force might be taken as uniform over its length, we had the relation: energy acquired = force × distance. If, however, the path were some centimetres long and the force variable from point to point, it was necessary to average it over the whole path, so that we had to deal not with its value at particular points, but with its integral over a considerable distance. Hence the requisite energy might be acquired even if over part of the path traversed the force acting on the particle was negative.

Professor Thomson stated that he had himself measured the distribution of the force in the neighbourhood of the striations. The convex side of a striation was turned towards the cathode of the tube, and he had found that just in front of the convex side of the luminous patch the force was negative; that is to say, it was tending to move the particles in the wrong direction. It then increased very rapidly as the striation was more closely approached, and rose to a considerable positive value. It then fell off again quite slowly to a negative value, and the cycle was repeated at the succeeding striation. All up the steep portion of the curve of electric force there was, the lecturer stated, a great preponderance of negative particles, whilst on the reverse slope of the curve of force the positive particles preponderated.

To map out the state of the electric force in the neighbourhood of the striations he had employed a fine stream of cathode particles shot across the discharge tube and falling upon a glass screen, where they produced a spot of phosphorescence. He had used for discharge tube the vacuum over the mercury in a very long barometer tube. The two electrodes were connected together by a sheet of glass, and the whole unit, thus formed, was floated on the mercury. By altering the level of the latter a striation could be moved up past the fine cross-stream of cathode particles, and the state of the field traversed by these was shown by the displacement of the phosphorescent spot on the glass. In cases in which the pressure in the discharge tube was too high to permit of cathode rays being produced, he had taken advantage of the fact that to produce a very short spark a big E.M.F. was required. He had, therefore, enclosed the cathode in a capillary tube, so that there was not room for the production of an ordinary spark, and cathode rays were obtained instead.

In this way he had found that the force might be actually negative on the cathode side of a striation, provided the pressure was quite low. At higher pressures it did not become actually negative, but fell much below its average value.

How, he continued, were stable striæ possible? Suppose we started with a particle moving slowly in a region where the force was very low. Its energy would then for a certain distance be too small to produce ionisation, and the tube would therefore show a dark patch. As the particle proceeded, however, it ultimately acquired a velocity sufficient to ionise the gas, producing thereby positive particles which moved so slowly that they might, as a first approximation, be regarded as at rest.

These positive particles remaining nearly stationary, whilst the negative ones moved on, counterbalanced somewhat the negative charge, but the field went on increasing until a point of the tube was reached where the number of positive particles present was equal to the negative particles there present. At this point the graph of the electric force became horizontal and then fell, since a negative particle having passed through this point would be attracted back by the positive charges left behind it. The rate of ionisation did not, however, begin to fall off at the same time as the field, since the position in which the electric force attained its maximum value was not the same as that in which its integral over a certain distance became a maximum, so that the energy of the negative particles still continued to increase for some time. Ultimately, however, it fell below the ionisation point, and the particle had then to pass through a portion of the tube in which there was again nothing but negative ions; but as it was approaching a region where the positive particles were again in excess, it acquired velocity afresh and the cycle was again repeated. The alternations of brightness characteristic of striation were in this way produced. To obtain them it was necessary that the drop of potential from centre to centre of two striæ should be less than would be required if the force were uniform over the whole distance.*

In conclusion the lecturer stated that the condition in which the total fall of potential required for the transport of the ions between two points was less with a non-uniform force than with a uniform one, held only between certain limits of pressure.

THE INSTITUTION OF GAS ENGINEERS.

THE fifty-fourth annual general meeting of the Institution of Gas Engineers was held at the Institution of Civil Engineers on Tuesday, June 5, under the presidency of Mr. Arthur E. Broadberry, M.Inst.C.E., chief engineer and manager to the Tottenham District Light, Heat and Power Company. The attendance was exceptionally good, the lecture theatre being crowded.

After the usual formal business the president of the Société Technique de l'Industries du Gaz en France, the Rt. Hon. Lord Moulton, K.C.B., F.R.S., Sir Arthur Duckham, K.C.B., Sir George Beilby, F.R.S., Dr. W. H. Perkins, F.R.S., and Dr. J. W. Mellor were elected honorary members of the Institution.

The president made reference to those associated with the Institution whose names were announced in the King's Birthday Honours list, which had been issued the previous day.

One of the principal subjects discussed in the presidential address, which then followed, referred to proposals for enlarging the qualifying limitations for membership. At present membership is restricted to professional men—those only who are in the engineering departments of gas undertakings or who are consulting gas engineers. Manufacturing and contracting gas engineers are excluded; the president urged the desirability of admitting them in order that the work of the Institution could be rendered more complete by their co-operation.

The anomalies of the sliding scale under war conditions were referred to. According to the president, when times were normal the system appeared to be more or less perfect, but under war conditions its effect had been very harsh on gas shareholders. War brought them burdens of their own in high prices for their own requirements, but it also brought the double burden of increased cost of gas production, which not only put up the price of gas and reduced their dividends, and so gave them less income to pay for the increased cost of living, but it also reduced the capital value of their shares. It was doubtful if things would ever be as they were, and therefore the time might come when in new Bills in Parliament the balance should be adjusted by the standard price under all sliding-scale companies being advanced. But the time was not yet. It could not be done in war time. How much of the disadvantage was permanent could only be known when the immediate and temporary effects of the war had passed. At present the sliding scale fetish was under suspicion, and unless it could establish its position after war conditions, it might prove to be quite a false god.

War applied the sliding scale to labour; and again the fierce light of war had searched out aspects which in the ordinary way would never have been expected. Co-partnership was based on the sliding scale. It postulated four essential features: first, security of employment for the worker; second, beneficial wage increase for good and effective combined work; third, accumulation of savings, impossible for voluntary thrift; fourth, unifying of employers' and workers' interests with those of the consumers.

It was a beautiful moral and sentimental ideal, and appeared to have a sound material foundation. War conditions had put it to a severe test. As the ultimate strength of any substance or body was ascertained only when it was tested to destruction, so co-partnership's real efficiency would never be known unless it reached the point when it was destroyed. Judged by the test of war conditions, the president feared co-partnership came in this category. He pointed out that recently every workman had shown a disinclination to be bound by any agreement; when the rising price of gas caused by war conditions produced a reduction in the co-partnership bonus simultaneously with attractive rising wages elsewhere, the adhesion of the workman to the system evaporated. Accumulation of savings was incompatible with voluntary thrift. In many cases very considerable sums accumulated as the effect of co-partnership. The value was known to be there; but the money could only be touched by the man leaving the service of his employer. This was another inducement to avoid any further agreement, and to leave service with the knowledge that increasing demand for labour made employment elsewhere easy to procure, while providing plenty of ready cash at the same time. Added to this the more thoughtful ones realised that, owing to the sliding scale, the dividends were becoming reduced, and the value of the stock in which they were compelled to invest was rapidly falling. They saw that the longer they remained in the service the less they would receive for their invested savings when they did at last change their employment.

As to the unifying of all interests, the president showed it was impossible to co-ordinate what did

* [As a mechanical analogy we would suggest the case of a gravity railway. It is known that the path of quickest descent between two points at different levels is not a straight line but a cycloid, and if passengers were to be transported between two such points the capacity of the line, or the number of passengers carried over it in a given time, would be greater if the line were laid out to the path of quickest descent than as a uniform gradient.—ED. E.]

not exist. In many cases no interest was left in co-partnership. He dilated upon his own experience at Tottenham, where the system had not succeeded. He said there might be, and no doubt were, cases where the test has not been so severe as at his works. There had been exceptional circumstances there. A pre-war agreement prevented the early raising of the price of gas, and this had the inevitable effect of a correspondingly heavy rise subsequently, which carried the price above the co-partnership standard. Reliance had long been reposed in carburetted water gas, which in normal times had enabled Tottenham to place itself in the forefront of low-priced undertakings, but war had produced a state of affairs that made carburetted water-gas production absolutely ruinous. Yet Tottenham, by reason of delays in the completion of the new coal-gas section, designed for a production of 4,750,000 cub. ft. per day, had been bound to it, and has been unable to escape.

This brought into a strong light another peculiarity of the gas industry not generally appreciated by the ordinary public—the fact that it was not in the power of gas undertakings to regulate the volume of their own business. The public helped themselves to the commodity supplied, and the undertaking was bound to fulfil the demands made upon it. It was a strange state of affairs when an increase of trade was undesirable and when a large decrease would be welcomed but could not voluntarily be obtained. Yet that state had existed in Tottenham for many months. If the company could have reduced its output by one-half it would have been thousands of pounds better off, because it could have discontinued the manufacture of carburetted water gas.

The president expressed the belief that a well-devised pension scheme would become the chief prop and stay of the co-partnership system. He paid a tribute to the late Mr. Ebenezer Topley, who was secretary to the Tottenham company, and had proposed such a scheme. Mr. Topley realised that a pension scheme, to be equitable and actuarially sound and to be equally divided between the employer and the employee, would bear financially so hardly on the employee that it would not appeal to him or enlist his sympathy. In connection with co-partnership, however, Mr. Topley foresaw the possibility of helping the worker to subscribe his half easily towards the fund.

In the beneficent co-partnership system there was the struggling worker, otherwise hopelessly unable to save as a provision against old age, being helped to invest in the funds of his employers by a scheme of bonus on his wages, one-half of which was withdrawable, and one-half compulsorily to be invested in the funds of the company. A very good investment, no doubt, in the light of things as they then existed, though not so good at the present moment of depreciated value. Mr. Topley thought, why should not the worker invest part in a still better scheme to provide himself with a good pension? He framed a plan which was declared to be actuarially sound, whereby the pension fund should be subscribed to equally by the company and co-partner, but only one-third of the co-partner's subscription should be deducted from his salary or wages. The other two-thirds should be charged against his investment—half of the co-partnership bonus. Surely a better investment even than the company's funds! After allowing a period of 10 years for maturing, it gave one-sixtieth of the maximum pay by way of a pension for each year's service up to a maximum of 40 years. Thus a man with even only 30s. per week would obtain 20s. a week pension at the age of 65 years (the retiring age) if he had been 40 years in the company's service.

Woman labour in gas works, coal supplies, education and training in preparation for work in gas engineering, and other important topics, were discussed in the address, which was considered one of the most valuable and suggestive that has been presented to the Institution.

After a vote of thanks had been passed to the president it was resolved that the council be requested to take into early consideration the suggested alterations of the constitution of the Institution, whereby its scope would be enlarged and rendered more comprehensive than is the case at present.

The election as president for the ensuing year of Lord Moulton, Director-General of Explosives Supply of the Ministry of Munitions of War, was then announced. His first act on behalf of the Institution was to receive from Mr. Broadberry a beautifully designed and executed roll of honour board, wrought of teak and metal from the old H.M.S. Britannia, on which were inscribed the names of members of the Institution who had joined His Majesty's forces, and of those who had made the great sacrifice. Lord Moulton placed a wreath upon it, the members rising from their seats.

In acknowledging his election his lordship said that the gas industry had supplied the country with the means of self-defence. Without the direct aid of the industry it would have been impossible for this country to have waged the campaigns of the last three years or to resist the overwhelming attacks that had poured upon it. Gradually we have seen ourselves creeping up to an equality with the supplies which our enemies had been piling up year after year in anticipation of the war; until now, he thought, our anxiety had passed away.

Afterwards the report of the Institution's Refractory Materials Research Committee was presented by the chairman, Dr. H. G. Coleman. We hope to publish this later. This was followed by the report of the Gas Heating, Lighting and Ventilation Research Committee, introduced by the chairman, Lieut.-Colonel Smithells, F.R.S., and presented by Professor John W. Cobb, Livesey Professor at the Leeds University. The annual meeting of the contributors to the benevolent fund was then held, and an adjournment was made for luncheon.

In the afternoon the report of the Research Committee on the "Life of Gas Meters" was considered, the president presenting it.

Opportunity was taken for the Coal Controller, Mr. Guy Calthorp, to address the meeting after the ordinary business had been transacted. He pointed out that the object of instituting the control of coal mines had been to get all the industries, as far as possible, to work together in the interests of the nation during the present crisis. He wished to disturb as little as possible the tendency of trade. He had two great problems to deal with. First of all the reasonable supply of coal to London and the counties of Great Britain most remote from the coalfields during the next winter; and generally they must help the railway companies in their present difficulty of transport.

The object of the new scheme was to secure that coal should be consumed as near as possible to the point of its output. The scheme, as far as they had gone at present, dealt with the output of 40,000,000 tons per annum. If they could secure the carrying out of the scheme it would materially assist the railway companies during the winter. If the war were over to-morrow the transport difficulty would continue. The transport of coal by ships from such places as Durham and Northumberland to the South of England could not bulk in the future anything like it had done before the war.

The meeting then rose for the day; next week we shall deal with the further proceedings, which included a visit to the works of the Tottenham District Light, Heat and Power Company.

NOTES.

The Ternary System, Iron–Boron–Nickel.

Professor N. Tschischewsky, of Tomsk, Siberia, presented two papers to the May meeting of the Iron and Steel Institute. The second of these papers, which we have published, dealt with the case-hardening of iron by means of boron. Boron makes the iron not only very hard, but also brittle, and in a paper contributed in 1915 to the Journal of the Russian Metallurgical Society, vol. i, pages 547–559, Professor Tschischewsky described attempts made by him, in conjunction with S. Mikhailowsky to retain the hardness of boron-steel, whilst reducing its brittleness by adding a third metal; the third metal chosen was nickel. It was found that nickel further increased the hardness and the brittleness of the boron steel; yet forging proved possible within certain reduced temperature ranges. The raw materials used were Swedish iron, ferro-boron of 19.56 per cent. B and 0.17 per cent. C, and pure nickel; finely powdered amorphous boron is unsuitable, as it burns at 700 deg. C. The metals were fused together in a Tammann electric furnace and cast into rods of about 40 grammes weight. In the analyses the alloys were dissolved in sulphuric acid, and iron and nickel deposited together with the aid of a mercury cathode; the nickel was then estimated by means of dimethylglyoxime, one of the organic reagents of the last decade or two, which have proved most useful, and to which Mr. A. Chaston Chapman drew attention in his lecture on "Advances in Modern Analytical Chemistry," delivered before the Chemical Society last March. The boric acid was determined by titration. The specimens were tested for hardness and malleability. The Brinell hardness test showed that the hardness of ferro-boron increased as the boron percentage rose to 2, decreased between 2 and 2.4 per cent. of B, and increased again when the boron percentage was raised to 4.32. The addition of nickel further increased the hardness without changing the general trend of the curves. The forging tests were conducted with a pneumatic tool. Iron containing 4.32 per cent. of boron could still be forged at dark red heat, whilst the 2 per cent. alloys were too brittle. The addition of nickel increased the brittleness as it raised the hardness; but it also lowered the temperature at which the alloy became malleable. Thus the 4.32 ferro-boron could be forged; an alloy with 4.22 per cent. of B and 2 per cent. of Ni was hardly malleable; 4.41 per cent. of B and 4.81 of Ni made the alloy more red-short, and an alloy with 4.24 per cent. B and 10 per cent. of Ni crumbled under the hammer. The experimenters assume that the brittleness is due to an increase in the proportion of fusible eutectic surrounding the crystals of hard solution, and that the addition of nickel raises that proportion. Hence the forging temperature should be lowered when the nickel percentage is high; then some of these alloys of great hardness might be utilised.

Rust Prevention in Ferro-Concrete.

The prevention of the rusting of the iron which is embedded in concrete for reinforcing it would be a simpler problem if concrete rich in cement, and thus in the lime, which protects the iron, did not incline to crack in shrinking. Once moisture gains access to the iron, the iron rusts and swells and in expanding cracks the concrete, and it is difficult afterwards to distinguish between cause and effect. In some laboratory tests the specimens can be kept free of fissures, and the results may be more satisfactory than in practice for that reason. If the iron could be made and maintained passive, rust formation could be avoided. It has long been known that chromic acid and soluble chromates will render iron passive, and a certain use is made of this property for the protection of boilers, circulation pipes and liquids, and when emulsion is wanted for cooling and lubricating on the lathe. There has also been some experimenting on concrete mixed with chromate solutions. An interesting contribution to this problem was published in the *Schweizerische Bauzeitung* of February 10, 1917, by Mr. B. Zschokke, of the Swiss Station for Testing Materials at Zürich. Zschokke uses potassium bichromate in two ways. He either mixes the cement with chromate solution instead of water, or he prepares a paste of Portland cement, sand and solution of bichromate in different concentrations, and paints one face of iron plates with this paste, the edges and back being painted with asphalt varnish. In the latter case the moisture should not be less than 50 per cent., else the hardening crust of concrete on the iron will peel off. The specimens are sprayed over with water containing carbon dioxide for the first five or six days; afterwards they become so hard that the concrete crust cannot be knocked off with a hammer. These specimens were exposed, together with ordinary cement specimens, for months in partly covered dishes, in which they rested on dry supports over water. The specimens prepared with ordinary water rusted very badly, in all cases, whilst the chromate plates kept perfectly free of rust and of

cracks. In other tests round irons, 18 mm. in diameter, were coated with a layer of cement and calcium or potassium chromate, which hardened in a day, and were then placed in a mould, the empty space being filled with concrete. In other tests, again, pieces of sheet iron were coated with ordinary concrete or chromate concrete, and lines were then scratched into the coating, exposing the bare iron; the rusting spread from these scratches in the ordinary concrete, but not in the chromate concrete, and other experiments confirmed the conclusion that the chromate protection will extend over small exposed spots. As the special painting of the iron with chromate concrete might be objectionable, the whole concrete was, in the other series, prepared with a 5 per cent. solution of potassium; the results were equally satisfactory. There remained the question whether the addition of chromate impaired the strength of the concrete or delayed the setting; there was no delay, though possibly a very slight decrease in the strength; in some cases an increase in the strength was observed. A chromate-concrete would cost from 3 per cent. to 5 per cent. more than an ordinary concrete, Zschokke estimates. He has applied for a patent, and although the basic idea is certainly not novel, it is quite conceivable that its application to building and engineering structure may form good subject-matter for a patent. The cost might possibly be reduced by diminishing the proportion of chromate; in aqueous solutions less than 1 per cent. of dichromate suffices to render the iron passive. The serious drawback, to which Zschokke himself directs attention, is that the chromate protection fails in the presence of certain common salts, alkali chlorides and sulphates, and also of considerable amounts of sulphurous acid vapours; the process could not be recommended, hence, for sea-water and acid atmospheres. On the other hand, the painting of iron pipes, &c., with chromates and other suitable materials should be further studied.

THE "ELECTRICIAN" TABLES OF ELECTRICITY UNDERTAKINGS.—The offices of *The Electrician*, 8, Bouverie-street, E.C. 4, have issued, at the price of 5*s.* net, a book of close upon 100 pages, containing their annual tables of electricity undertakings. Tables A deal with the British electricity supply undertakings arranged alphabetically according to towns, the information including, among other items of interest, the name of the company or corporation; system of generation, transmission and distribution; current; voltage; connections; power; load; capacity; fuel used; price of current per unit, &c.; tables B give similar data on the British electric power companies; tables C deal with the Colonial and foreign electricity supply works and with the electric railways and tramways of the world. The book contains a vast amount of useful information on the subject and is of very easy reference.

THE MUNITIONS CAPACITY OF THE UNITED STATES.—The president of the Bethlehem Steel Company, Mr. E. G. Grace, is reported by *The Iron Age* to have recently stated that at the beginning of the war the shell-making capacity of the whole United States was practically negligible. At the present time the Bethlehem Steel Company had capacity for 1,000,000 rounds per month. At the beginning of the war facilities for the making of field guns in America were insignificant. At that time the entire English army had only about 600 field guns. At the present time the Bethlehem works were turning out 100 finished guns per month, as well as over 2,000 gun forgings which could be completed elsewhere. With proper co-operation between the Government and the various shipbuilding companies, and with provision made for an adequate supply of raw material, it would be possible for the United States rapidly to construct an amazing tonnage of new ships. "This will make it certain," added Mr. Grace, "that our Allies shall not want for adequate assistance or the means of subsistence."

ALLIED DECORATIONS CONFERRED ON ENGINEERING OFFICERS OF THE ROYAL NAVY.—The following decorations were conferred by the Russian Government on officers of the Grand Fleet for distinguished service rendered in the Battle of Jutland:—*Order of St. Anne, 2nd Class (with Swords):* Engineer Captains John Richardson, C.B., Archie R. Emdin, Howard Bone. *Order of St. Stanislas, 2nd Class (with Swords):* Engineer Commanders William Toop (now Engineer Captain), William C. Sanders, D.S.O., George F. Thompson, Robert Spence, D.S.O., Reginald W. Skelton, D.S.O., Walter F. Mitchell, Charles F. Dunn, John D. Wilson, Cecil H. A. Bermingham, James P. Leahy, Henry W. Kitching, D.S.O., Walter S. Hill, John L. Kimber. *Order of St. Anne, 3rd Class (with Swords):* Engineer Commanders John B. Hewitt, Malcolm C. Johnson, David E. Duke, Ernest F. Baker, Arthur F. Sawyer, Jonathan J. Screech, Clifford Howle, Arthur L. Picton; Engineer Lieut.-Commanders Arthur E. Shilleock, Thompson Gurnell, Ernest W. Roberts, Richard J. Brown. His Majesty the King has given unrestricted permission to the officers named to wear the decorations in question.

INDUSTRIAL NOTES.

THE Ministry of Munitions recently announced that the further stages of the Munitions of War Bill in the House of Commons would not be taken until certain negotiations now in progress have been concluded.

Dr. Addison was in consultation with the Amalgamated Society of Engineers and other trade unions affected by the Bill, as well as with representatives of employers, with the object of securing a general understanding of the provisions of the Bill and of coming to an agreement in regard to the amendments proposed by various organisations.

These amendments include a proposal that before the principle of dilution is applied to private work of any particular class public notice shall be given and opportunity afforded for consultation, if necessary, with the parties concerned.

Concurrently with these negotiations on the Bill Dr. Addison was taking the opportunity of ascertaining whether he could include in the Bill certain amendments of the Munitions of War Acts in respect of leaving certificates and other matters which had been found to cause inconvenience and unrest.

The negotiations were proceeding satisfactorily and would be carried through as expeditiously as possible. This subject is referred to in our leading article.

A communication issued by the Press Bureau on the 2nd inst. says that considerable misapprehension seems to prevail with regard to the award of the Committee of Production in respect of the wages of employees in the engineering and foundry trades. This award, which began to operate on April 1 last, was limited in its application to employees of members of the societies included in the Engineering Employers' Federation who are engaged in the federated shops and foundries, and its general effect has been to increase the wages of men 5*s.* per week and the wages of boys and youths 2*s.* 6*d.* per week.

There is no foundation for the statement, widely circulated in some parts of the country, that the Minister of Munitions has authorised an advance of 5*s.* per week to munition workers irrespective of the trades in which they are employed. But the Minister has undertaken to extend the award of the Committee of Production so as to make it applicable to the employees of all unfederated firms in the engineering and foundry trades under his control, and a clause has been inserted in the Munitions of War Bill to empower this extension.

Meantime, as a result of the action of the Minister of Munitions, the award of the Committee of Production has been adopted almost universally throughout the engineering and foundry trades. The award has also been voluntarily adopted by the Midland Employers' Federation, with its 337 members, and by other branches of the metal trades not directly affected by the decision of the committee; while over a wide area in the chemical industry advances of 5*s.* per week have been given to men and 2*s.* 6*d.* a week to boys and youths by award or agreement.

In pursuance of the powers conferred upon him by the Defence of the Realm Regulations, the Minister of Munitions has ordered that the war material to which the regulations apply shall include war material of the following classes and descriptions, namely:—

All machinery driven by power and suitable for use in cutting, working, or operating on wood, including: sawing machines of all descriptions; general joiners; mortise, tenon and boring machines; lathes and rounding machines; box and cask-making machines, and all machines accessory thereto; scraping and sand-papering machines; wheelwright machinery; firewood making and bundling machinery; wood wool-fibre and pulp machinery; saw sharpening and setting machines; saw stretchers and brazing apparatus. All machines for grinding, planing or moulding irons.

All applications for a permit to purchase or enter into negotiations for the purchase of the war material referred to in the above Order should be made to the executive officers of the Area Clearing House Boards, whose addresses may be obtained upon application to The Director, Central Clearing House, Ministry of Munitions, Charing Cross Buildings, S.W. 2.

All applications for a permit to sell or enter into negotiations for the sale of the war material referred to in the above Order should be made to The Director of Wood-Working Machinery, Charing Cross Buildings, S.W. 2.

With a view to removing misconceptions which have recently arisen in various parts of the country, the Minister of Munitions directs attention to the fact (1) that no building or construction work costing over 500*l.*, or involving the use of constructional steel, can be undertaken without a licence from the Ministry, and (2) that such a licence is as necessary for work involved in the restoration of property destroyed or damaged by fire or aircraft as for work undertaken in other circumstances.

We are informed that a conference of employers and operatives in the wool textile trades of the Bradford district was held last Monday, the 4th inst., at Bradford. The Lord Mayor, Alderman Abram Peel, occupied the chair. The employers and operatives were in complete agreement, and a resolution was passed to the effect that no work will be done on Mondays. The week's work will commence on Tuesday mornings and end on Saturday midday. This restriction in working hours is necessary to meet the recent Army Council Order dealing with economy in the use of wool.

A meeting of the Tees Conservancy Commissioners was held last Monday, the 4th inst., when it was decided to sanction the transfer of 21 acres of land on the river front at Stockton-on-Tees to the East Coast Steel Corporation, for the construction of iron and steel works, at a cost, it is stated, of 3,000,000*l.* Construction is to commence shortly.

We read in *The Liverpool Courier* that a meeting of the Liverpool employers will shortly be held under the auspices of the National Alliance of Employers and Employed, recently formed in London for the purpose of preventing industrial unrest.

A conference of labour delegates dealing with the same subject was held at the Adelphi Hotel on Thursday May 31, Mr. George Milligan being in the chair. The members present held a watching brief on behalf of the Liverpool and District Transport Workers' Federation of dockers, carters, stewards and seamen and firemen, the Engineering and Shipbuilding Trades' Federation of about 40 trades engaged in the construction and repairing of ships, and the Bootle and Birkenhead Trades Councils. By some oversight the Liverpool Trades Council was not represented.

Mr. A. H. Paterson addressed the meeting, indicating the aims and objects of the movement. Based on the idea that unnecessary Government interference is resented by employer and employed alike, the alliance had been formed:—

(1) To secure the active co-operation of employers and employed in the discussion and treatment of questions affecting labour and employment, with the special object of securing that these should be dealt with before they have reached the stage of acute controversy.

(2) To promote, generally, the welfare of industrial workers of the country, and efficiency of its industries.

(3) To arrange, in conjunction with the proper departments of the Government, as one of the most urgent problems, for the reinstatement in civil employment at the end of the war of men serving with the forces and munition workers.

(4) To provide the organisation necessary for the carrying out of the foregoing objects by the creation of a central council and local committees, consisting in each case of employers and employed in equal proportions.

There were, he said, already in the alliance employers representing most of the great manufacturing and business firms, and a large number of well-known labour leaders. The funds of the union would be found in equal proportions by both sides, and the voting power would be equal. The administration would be through a central council and executive committee, sub-committees and local committees. No agreements existing between employers' associations and trade unions would be interfered with by the alliance.

Mr. Havelock Wilson then outlined the part the Seamen and Firemen's Union had played in welcoming and supporting the alliance.

Mr. Tom Mann stated that he had always been suspicious of employers, and whilst he was always prepared to maintain the workmen's right to strike, if necessary, he welcomed the principle of agreement by negotiation to prevent strikes and lock-outs.

After further discussion it was agreed to report back favourably on the scheme to the various unions and other local labour bodies concerned.

A printed obligation of loyalty has been distributed among the employees of the Union Iron Works, San Francisco, says *The Iron Age*, with the request that each employee should sign the obligation form and return it to the general manager's office. The obligation reads as follows:—

"I do solemnly swear that I will bear true faith and allegiance to the United States of America, and that I will serve them honestly and faithfully against all their enemies whomsoever, and that I will obey the orders of the President of the United States and the orders of the officers appointed over me.

"I do also solemnly swear that I will serve honestly and faithfully the Union Iron Works Company and will allow no person to cause any loss or damage to a fellow employee or any loss or damage to the property or interests of the Union Iron Works Company; and I do

take these obligations freely without any mental or other reservation; so help me God."

To assemble quickly 10,000 men skilled in the construction, operation and maintenance of industrial and standard-gauge railways, says *Engineering News-Record*, New York, is the job presented by the War Department in calling for the organisation of nine engineer regiments for immediate service in France. There has been a rush of men eager to enlist, but it is significant that out of many hundred applicants who appear daily at the recruiting headquarters a very small percentage proves acceptable. To expedite recruiting at the New York station, a number of well-known contractors, headed by Mr. F. J. MacIsaac, president of the General Contractors' Association, have volunteered to aid in the selection of recruits. This action may well be followed in other localities where regiments are being formed. There is no better judge of men than the experienced contractor. He can be depended upon to sift out the unqualified candidates in the line and thus establish a sort of preferred group for the recruiting officers to consider.

In a recent issue of the Liverpool *Journal of Commerce*, Mr. D. R. Bremner, M.Inst.M.E., M.I.E.E., M.I.M.M., has contributed an article on "Employer and Employed," in which he states that no sane and wise employer wants, after the war, to go back to pre-war conditions, and adds that it is very doubtful whether any intelligent discerning employee does. To revert to pre-war trade unionism, with its restriction of output and fratricidal strife, would be to open an industrial artery before commencing to discuss ways and means of securing a healthy vigorous life in defiance of new destructive influences . . .

For the checking of the abuses which have occurred and for the betterment of its conditions labour has in the main to thank its own powers of combination and organisation, the unselfish mutual support of its various sections, and the willingness of the individual to make sacrifices, involving real privation, in the interests of the class to which he belongs. It is not to be wondered at, therefore, that the trade unions should decline to surrender the hardly-won fruits of their struggles and sacrifices before they have received satisfactory guarantees of adequate compensatory advantages.

Both the trade unionists and the employers are clearly entitled to retain their respective instruments of negotiation and their lien on the *status quo ante bellum* until the terms of a settlement have been mutually agreed upon . . .

Whatever the political and social quacks and cranks may say to the contrary, there is no possibility of combining all-round inefficiency and lassitude with material prosperity and spiritual welfare. . . . Although a new spirit is abroad, and many good and true men of both classes are striving to pave the way for a better understanding and improved mutually helpful relations between employer and employed, it would be absurd to believe that human nature will undergo a sudden radical change, bringing the millennium within our reach. Not all employees are good nor all employers bad. There are good, bad and indifferent in both classes. The ignorant, the selfish, the dishonest and the brutal will continue to exist, and by their malign influence hamper the efforts of their fellows. All we are entitled to believe is that the average of each class is reasonably competent, honest and anxious to do the right thing. . . . The flatulent eloquence of the crank and the rancorous shouts of the fanatic must no longer be allowed to drown the voices of those whom they so wickedly misrepresent. Much cowardice, lethargy and apathy go by the name of tolerance.

In concluding the article in question, of which the above is an abstract, Mr. Bremner says that it is possible now to state without hesitation or qualification that labour's expectation of payment on a scale corresponding to a purchasing power hitherto unapproached in peace time cannot be realised with any degree of permanence unless the productivity of labour is more than correspondingly increased. He says: "more than correspondingly" because the productivity of labour before the war had sunk below a fair and reasonable standard, and there was leeway to recover. Furthermore, we shall require substantially to increase our wealth production per head of population in order that we may progress under the heavy financial burdens imposed by the war. The situation can be met only by unrestricted and facilitated output; output unrestricted by any written or unwritten laws of labour organisations, and facilitated by scientific and humane methods of organisation on the part of the employer. We can no longer afford to tolerate slackers in the ranks of labour or duffers in the positions of command and authority.

By direction of the War Cabinet Dr. Addison, the Minister of Munitions, has made arrangements for the appointment of an interdepartmental committee to prepare a scheme for the establishment in London of an Imperial Mineral Resources Bureau (*a*) to collect information in regard to the mineral resources and metal requirements of the Empire, and (*b*) to advise what action, if any, may appear desirable to enable such resources to be developed and made available to meet requirements.

The committee consists of the following gentlemen:—Sir James Stevenson, Bart. (chairman); Mr. C. L. Budd; Sir A. Duckham, K.C.B.; Professor W. R. Dunstan, C.M.G.; Mr. C. W. Fielding; Mr. J. F. N. Green; Right Hon. Lord Islington, G.C.M.G.; Mr. L. J. Kershaw, C.I.E.; Sir T. Mackenzie, K.C.M.G.; Hon. Sir G. H. Perley, K.C.M.G.; Mr. W. S. Robinson; Right Hon. W. P. Schreiner, C.M.G., K.C.

The secretary to the committee is Mr. Oswald C. Allen, and all communications on the subject should be addressed to him at the Ministry of Munitions, Whitehall-place, S.W. 1.

DRAUGHTSMEN AND FOREMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—Kindly allow me a few words in reply to your correspondent Mr. Clausen, in your issue of June 1, who quotes that your correspondent in May 25 issue had acquiesced in the idea that a draughtsman's work is unproductive. This idea is a fallacy, as he points out, and in my letter to your valuable paper of May 18, under the above heading, he will find that there it was pointed out that although the draughtsman is often considered to be on the unproductive side of an engineering works, I wondered how *much production would be going on without him*. Surely that is not implying that the often-expressed opinion is a true one. My views, in fact, are that he is, with the engineer-in-charge, *the head of the productive part* of an engineering works.

His further remarks compare the draughtsman's status with those of a lawyer or doctor—and why not? We may not have got to the point of Government-sanctioned examinations for draughtsmen, but that is the goal we are striving for, and many firms have already initiated such a system of their own free will to help apprentice draughtsmen and train them. That there are no examinations for draughtsmen is not so much their fault as that of our Government and its antiquated educational system; other countries exact from their draughtsmen examinations at technical schools and high schools, and in these countries draughtsmen are paid better accordingly. Why should we not do so here in England? But things move here notoriously slowly; so we must do like Mr. Asquith.

Draughtsmen, have, however, wakened up to their responsibilities and their claims, and the Association of Engineering and Shipbuilding Draughtsmen, with headquarters at 94, Hope-street, Glasgow, and branches everywhere in Great Britain and Ireland, is working hard for this purpose, including that in the near future no man shall become a member of the association unless he is fully qualified.

The present critical period is, however, not suitable to further this object, but time will no doubt bring us changes for the better, as a keen interest is shown everywhere to work towards this object.

Yours truly,
June 6. "STAFF."

"THE ELECTRICAL PROPERTIES OF GASES."

TO THE EDITOR OF ENGINEERING.

SIR,—The interesting letter from "Credoindeo" is one with which I am in substantial agreement, with the possible exception of his last sentence, which without amplification might, I think, be misleading. Admittedly all our knowledge as to externals is hypothetical, but in the nature of things the evidence in favour of any particular hypothesis varies greatly in weight. The question then arises as to when it is permissible to pass from the accurate statement "I venture to think" to the *always* inaccurate but colloquially legitimate and convenient expression "we know." It seems to me that this transition from the one phrase to the other is fair and reasonable when those who have made a special and prolonged study of the evidence have, after mutual criticisms of each other's work on the point at issue, arrived at the same general conclusion. This is now the case in regard to the electron and as to the atom being built up of components which may be popularly described as analogous to planets and suns. On the other hand I gather that this unanimity has not yet been reached as regards Planck's "quantum" of energy, useful as the conception has proved. Being, however, an engineer and not a physicist, I speak on this point with reserve.

I think history supports the view above put forward. Naturally, what is "known" in this sense to one generation may in the same sense be "known" to be untrue to a later one, as happened with the geocentric theory. The man in the street now "knows" that the earth rotates on its axis, though all the evidence to which he has direct access would lead him to a different conclusion. What he means is that he is informed that those who have studied all the evidence available, and not merely that accessible to himself, are agreed as to the earth's rotation. Of course, we have still with us a certain number of flat-earth cranks who insist on forming their own opinion from the direct evidence of their senses.

A marked characteristic of the crank is that he is imbued with the idea that scientific men are in a conspiracy to back each other up (right or wrong). His ignorance of scientific history prevents him from realising that every new hypothesis is a cocksby for every experimentalist the world over who may be interested in it. A young scientist's reputation is made if he can find a flaw in the experimental or theoretical work of a leading man. Indeed, a young biologist, a near relative of the writer, was advised by Professor Huxley never to miss a chance of pitching into the work of a "big gun." Of course Huxley meant this to take the form of a reasoned argument showing in detail where the observations or conclusions criticised were in error.

Just one other point. Though not a professed student of philosophy, I am under the impression that the pragmatists would not accept "Credoindeo's" statement that "a working theory" is useless for the philosopher.

Yours faithfully,
Croydon, June 1, 1917. DIDYMUS.

TO THE EDITOR OF ENGINEERING.

SIR,—I am sorry to find myself under the lash of "Didymus's" heavy whip, but I confess my ignorance of history and science, and would be grateful for his help in understanding matters if he will kindly assist me. I do not wish to waste his time, nor to suck his brains on the cheap; so I enclose a reprint of my little article, and I will gladly pay to him whatever fee you, sir, may think reasonable for such corrections as "Didymus" may be good enough to make—my little article being, as I stated in its opening paragraph, "an earnest appeal to those who know better to assist in making clear matters which are not quite precisely nor correctly defined; and it is, withal, an honest confession of faults that need corrections."

Your obedient servant,
June 4, 1917. "AN OLD MILLWRIGHT."

TO THE EDITOR OF ENGINEERING.

SIR,—At the risk of being subjected to more abuse from "Didymus," I do not express any opinion as to the "precise significance" of a word not used by me—except as part of a quotation. I never wrote "merely quote Sir J. J. Thomson;" and the attempt to juggle with "merely" is not worthy of "Didymus."

Leaving him to stew in his own juice, pray let me repeat my questions:—

1. How can it be demonstrated that, concerning the structure of matter, "beyond the chemical atoms which make up the mass of ordinary bodies still smaller systems existed, each chemical atom being a little universe comprising many planets and suns?"
2. How do "we now know that electricity was, so to speak, atomic in structure?"
3. Is electricity, if atomic in structure, ponderable?

Yours faithfully,
2nd June, 1917. EARNEST STUDENT.

FANS AND CENTRIFUGAL PUMPS.

TO THE EDITOR OF ENGINEERING.

SIR,—With a view to correcting a false impression that may be gained, I beg to draw your attention to a sentence on page 513 of the current issue of ENGINEERING. In reviewing a book on the "fan" your reviewer says: "Mr. Innes was, we believe, the first to connect the theory of the fan with that of the centrifugal pump, to which a close resemblance is traceable, though the fan does not actually lift air as a pump does water."

As regards the first part of this sentence it is interesting to remember that the identity of the theoretical treatments of centrifugal fan, water turbine and centrifugal pump was quite well understood by M. Charles Combes, long before Professor Innes' time. An examination of M. Combes' "Aérage des Mines," in the *Annales des Mines—Troisième série, Tome xv*, 1839 (see Supplement also in 1840), where, on pages 210 to 237, he gives a treatment of centrifugal fans, and his "Recherches Theoretiques et experimentales sur les roues à réaction ou a tuyaux," in the *Annales des Mines*, 1840, shows clearly that he applied the same equations and methods to fans, wheels and pumps.

Another instance proving that the connection between the laws of fan and pump behaviour were recognised is furnished by the development of Mr. Appold's curved vane pump in 1851. Mr. Appold was a manufacturer of fans (he made the Lloyd fan, patent 12087, A.D. 1848), and centrifugal pumps, and all he did to evolve his well-known pump was to adopt with centrifugal pumps what had been proved after long experience to be advantageous with centrifugal fans, *i.e.*, a recurved vane.

Regarding the last portion of the sentence quoted it is quite difficult to see what meaning is intended to be conveyed. As a physical fact the converse of what is said is much nearer the truth. A centrifugal pump cannot lift water at all, as is well known. The water must be brought to the eye of the impeller in the first instance, after which, provided the suction pipe is maintained as a vacuum tube, the pump will do work against the suction pull and will maintain a delivery of water. On the other hand, a fan arranged similarly with a suction pipe will actually lift air.

Yours faithfully,
OWEN A. PRICE.

"Westray," Yarborough-road, Lincoln, June 3, 1917.

[We thank our correspondent for his historical references. As regards the final paragraph of his letter the simple fact is that neither a fan nor a centrifugal pump can do its work until its chamber is charged with the element with which it has to deal. The fan may thus be regarded as being under the same conditions as a submerged centrifugal pump.—ED. E.]

ENGINEERS AND THE BIRTHDAY HONOURS.

A NEW order, to be known as "The Most Excellent Order of the British Empire," is to be created. It was arranged that a list of appointments to this Order would have been announced on Saturday. It has been delayed, and until it appears one must not criticise too closely the list of honours on the occasion of His Majesty's birthday, because it is understood that the new Order has been created primarily to acknowledge the great services and devotion of those engaged in war work, notably those who have done such continuous and unflagging service in the provision of material for the Navy and the Army. Otherwise the list of birthday honours would be subject to criticism, because of the apparent lack of appreciation on the part of the Advisers of the Crown of the work of engineers, naval and civil. Indeed, the honours very largely reward political service, and the list is only rendered of public interest because of the inclusion of a few distinguished members of the Army, Navy and industrial forces, with a few servants of the State, who well merit the acknowledgment of worth conferred by such honours. The list is a long one, embracing five viscounties, five baronies, eight Privy Councillorships of the United Kingdom and two of Ireland, 25 baronetcies and 50 knighthoods, in addition to appointments to and promotions in various existing Orders.

As to the new Privy Councillors, the inclusion of two trade union leaders will give satisfaction. The one is Mr. James Henry Thomas, M.P., who since 1890 has been secretary of the National Union of Railwaymen, and who has risen from the ranks to an influential position, not only in his union, but in the legislature. The other is Mr. Thomas Ashton, general secretary of the Miners' Federation since 1889. He began life in the pits, and now, at 73 years of age, occupies an influential position. Of the baronets, four are well known to engineers, namely: Mr. George S. Clark, managing director of the well-known Belfast shipbuilding firm of Workman, Clark and Co.; Mr. William C. Gray, chairman of the Hartlepool shipbuilding firm of William Gray and Co.; Sir Robert Hadfield, a distinguished metallurgist and chairman of the noted Sheffield firm that carries his name; and Sir Philip Magnus, who has done such valuable work in the promotion of technical education. Amongst the knights are several men who have won distinction. All will be gratified at the honour conferred upon Dr. R. T. Glazebrook, the Director of the National Physical Laboratory since 1899, who was made a C.B. in 1910. The same applies to Mr. J. A. F. Aspinall, the general manager of the Lancashire and Yorkshire Railway since 1899, and for many years prior to that the locomotive engineer of the company. Mr. Francis H. Barker, who is closely identified with the Parsons Foreign Patents Company, Limited, and other media for the development of trade, and is, further, a director of Vickers, Limited, is also entitled to his honour. The other notable new knights are Messrs. Ebenezer Parkes, ironmaster; Samuel Roberts, a director of Cammell, Laird and Co.; and Edward Graham Wood, a Lancashire ironfounder.

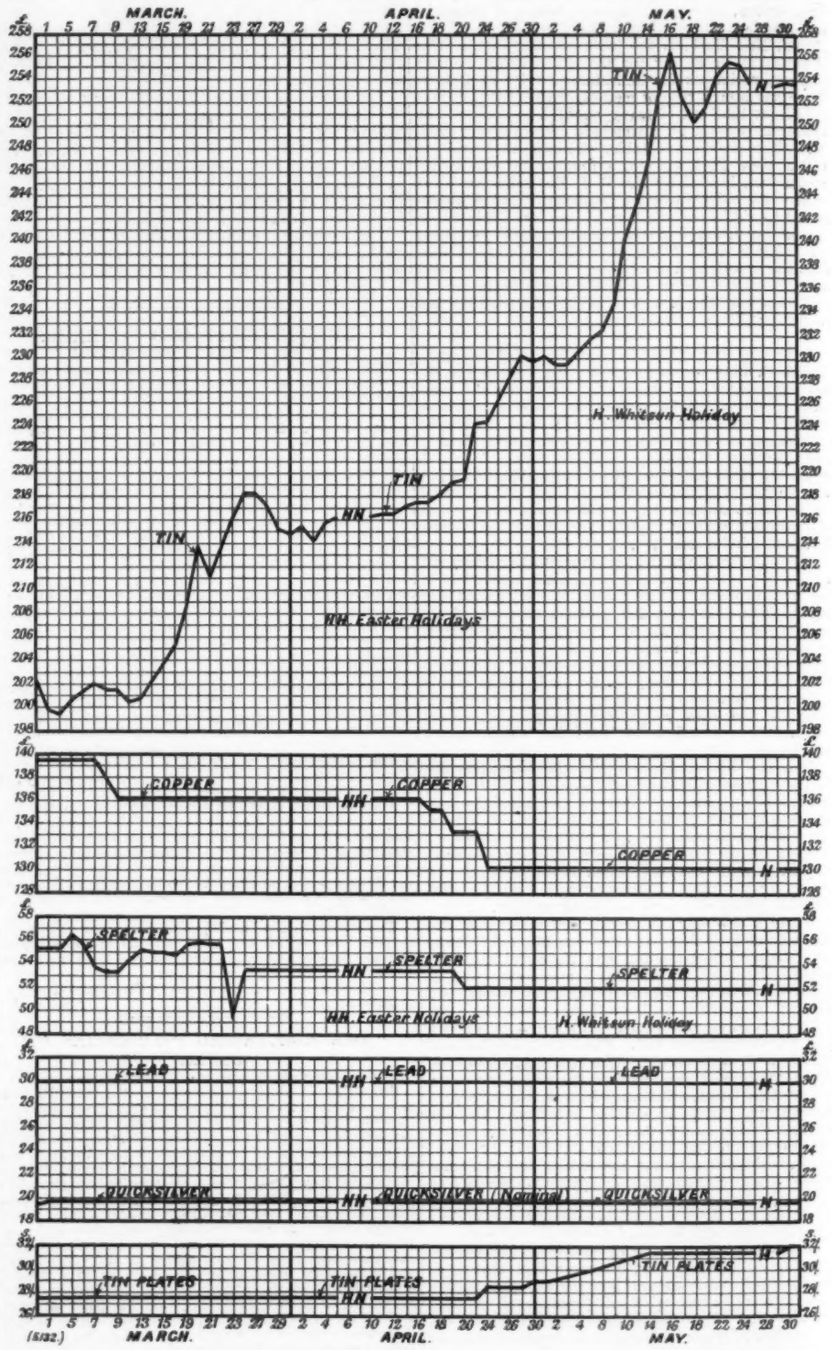
The Navy list includes appointments to and promotions in the Bath for several well-known engineering officers. A C.B. in the Military Division has been conferred upon Engineer-Captains H. Bone and C. C. Sheen, while a C.B. in the Civil Division has been conferred upon Engineer-Captain J. W. Ham, who recently retired to join the directorate of Messrs. J. Samuel White and Co., East Cowes; Mr. W. J. Berry, of the Royal Corps of Naval Constructors, who has just been appointed director of Warship Production; Mr. H. Cartwright Reid, Superintending Civil Engineer, who has been for so long in charge of the works at various naval ports—the latest at Rosyth; and Mr. H. H. Law, Chief Engineer-Inspector to the Local Government Board. The small number of naval engineers in the list requires much explanation.

In the Colonial list, Mr. F. E. Kanthack, M.Inst.C.E., a Director of Irrigation, Union of South Africa, is made a C.M.G.; while in the Indian list the honour of knighthood has been conferred upon Mr. M. Nethersole, C.S.I., Inspector of Irrigation, and a C.I.E. on Mr. Holman Hunt, A.M.I.C.E., also of the Public Works Department, as executive engineer, Twante Canal Division, Burma, and on Chief Engineer T. H. Knight, Royal Indian Marine, Inspector of Machinery at the Bombay Dockyard.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The forty-fourth annual general meeting of this Institution is to be held at the Town Hall, Hastings, on Thursday, Friday and Saturday, the 28th, 29th and 30th inst. Several papers are to be read and discussed. They deal with "Public Abattoirs"; "Extraordinary Traffic and Excessive Weight on Highways"; "Examinations"; "Dry Rot"; and "Some Municipal Works of Hastings."

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal and Scotch Pig-Iron Warrant Markets.)



NOTE.—In the diagram above the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange, as far as they have been reported, for "fine foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. The prices are per ton, but in the case of quicksilver, however, the price is per bottle; the price of tin-plates is per box of I.C. cokes free on board at Welsh ports Each vertical line in the diagram represents a market-day, and the horizontal lines represent *1l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each. On July 7 the Minister of Munitions issued a list of maximum prices and regulations governing the dealing in certain metals, &c.; thus the price of hematite pig was fixed at 6*l.* 2*s.* 6*d.*, Scotch at 5*l.* 14*s.*, and Cleveland at 4*l.* 11*s.* 6*d.* per ton. Ship-plates were priced at 11*l.* 10*s.*, and heavy steel rails at 10*l.* 17*s.* 6*d.* per ton. These quotations are still in force. (For official regulations see page 45, vol. cii.)

PERSONAL.—Mr. F. Evill, the London representative of the Klein Engineering Company (1908), Limited, and of the Timbrell and Wright Machine Tool and Engineering Company, Limited, has removed to 159, Victoria-street, S.W. 1.

PLASTER OF PARIS.—The researches of L. A. Keane (*Journal of Physical Chemistry*, vol. xx, pages 701 to 723) confirm the observation that dead-burned plaster, which will not set with water, may be regenerated by grinding it very fine.

AN ANALYSIS OF MODEL SCREW PROPELLER EXPERIMENTS.

By S. MOTORA.

[WE print below a slightly abridged prize essay, afterwards communicated to the (Japanese) Society of Naval Architects. Mr. Motora, the author, is an assistant at the experimental tank of the Mitsu Bishi Company, at Nagasaki. In his analysis he does not introduce any new material, but contents himself (very ably, be it said) with adjusting the data of Froude and Taylor to the designer's needs; in a rather tantalising sentence he says: "I have analysed the trial results of several ships, and found the majority of C_n and C_b values thus found to lie between A A and B B," but he gives no illustrations to prove the truth of this statement.]

Assuming T, the thrust, and V, the speed of advance of the propeller, to be known, he constructs curves of $\frac{\sqrt{T}}{V^2}\,n$ (which he calls C *n*, or the revolution factor) and $\frac{V}{\sqrt{T}}\,D$ (C *d*, or the diameter factor).

T = Thrust in tons.
n = r.p.m.
V = speed of advance of propeller, in knots (= ship's speed − wake).
D = diameter in feet.

The essential part of his paper then proceeds:—

In designing a propeller T and V may be taken as known quantities. Supposing a ship be required to be driven at an assigned speed, the resistance of the ship at that speed is readily estimated by model experiments or by some other methods. Then T and V may be computed by the formulas

$$T = \frac{R}{1-t}$$

$$V = (1-w)\,V_s$$

where V_s = speed of the ship,
R = tow-rope resistance of the ship at the speed V_s,
t = thrust deduction factor,
w = wake factor.

To obtain the accurate values for thrust deduction and wake factor is another difficult problem. But since it is beyond the purpose of this paper it will not be described at length here. For the present we may take T and V as given. The next things to be considered are the number of revolutions, the diameter, the pitch ratio and the area ratio. Of these four quantities, the first two are more or less restricted within certain limits, the number of revolutions being in close relation with the propelling machinery, and the diameter being limited by the ship's draught. On the other hand, pitch ratio and area ratio are not limited in any way. If we assume suitable values for the number of revolutions and diameter, we should select *p* and *a* without any restriction for their magnitudes, so as to get the maximum efficiency attainable. Hence the number of revolutions and the diameter may be taken as the primary independent variables, and the efficiency, the pitch ratio, and the area ratio as the dependent variables, the thrust and the speed being supposed to be given quantities. Since both of the variables $\frac{T}{D^2 V^2}$ and $\frac{V}{n D}$ contain D, there is some inconvenience in using the chart. To avoid this, $\frac{V}{\sqrt{T}}\,D$ and $\frac{\sqrt{T}}{V^2}\,n$ may be taken as primary variables where the former is the square root of the reciprocal of $\frac{T}{V^3 D^2}$ and the latter is the reciprocal of $\frac{V}{n D}$ multiplied by the square root of $\frac{T}{D^2 V^2}$.

For brevity, denote $\frac{\sqrt{T}}{V^2}\,n$ by Cn and $\frac{V}{\sqrt{T}}\,D$ by C_D. C_n and C_D, therefore, represent *n* and D respectively in certain scale. Hence we can, at a glance, find efficiency corresponding to the values of *n* and D which are to be adopted, or determine *n* and D which will give the greatest efficiency, harmonising with other requirements such as the engine speed and the ship's draught.

There are two valuable papers published on model screw propeller experiments, namely, "Results of Further Model Screw Propeller Experiments," by Mr. R. E. Froude, and "Speed and Power of Ships," by Mr. D. W. Taylor, Naval Constructor U.S.N. (see table on page 557). It will not be necessary to enter into details of their investigations. A brief description will suffice.

(For constructing the charts mentioned below, the method is explained in an appendix, not here given.)

Figs. 1, 2, 3, 4 and 5 are calculated from the experimental results of Mr. Froude. Figs. 1 and 3 are the efficiency charts for three and four-bladed screws of elliptical blades respectively, corresponding slip ratios being shown in dotted lines in the same charts. Figs. 2 and 4 represent the contour lines of pitch ratio and area ratio also for the two kinds of propellers. It should be remarked that the pitch ratio used in the analysis of Mr. Froude's experiments is the analysis pitch ratio defined by him, and consequently the slip ratio shown in Figs. 1 and 3 is not the nominal slip ratio, but is computed by using the analysis pitch ratio. Fig. 5 is constructed by superposing Figs. 1 and 3—the explanation of this chart will be found later on. Figs. 6, 7 and 8 are computed from the experimental data obtained by Mr. Taylor. Fig. 6 shows the efficiency of the three-bladed elliptical type with thickness ratio of 0.04, Figs. 7 and 8 being the same as Fig. 6, except that the thickness ratios are 0.06 and 0.08 respectively.

In comparing the Figs. 1, 6, 7 and 8 it will be found that the contour lines obtained from these two data are quite similar in their configuration, there being only

Fig.1. EFFICIENCY & SLIP RATIO. THREE BLADED ELLIPTICAL SCREWS. (FROUDE).

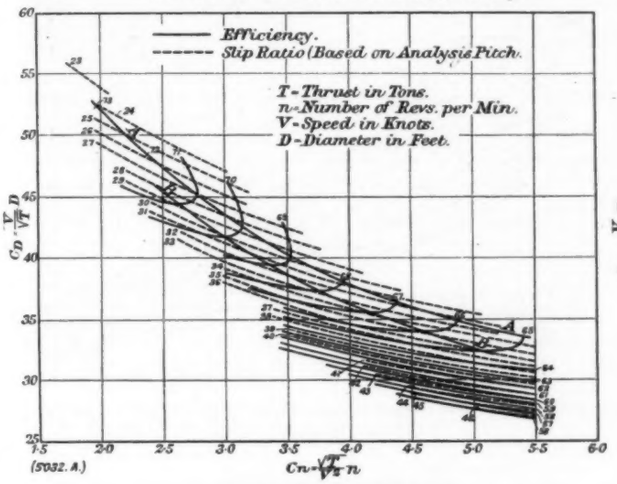

Efficiency.
Slip Ratio (Based on Analysis Pitch.
T - Thrust in Tons.
n - Number of Revs. per Min.
V - Speed in Knots.
D - Diameter in Feet.
(5032. A.)

Fig.2. PITCH RATIO & AREA RATIO. THREE BLADED ELLIPTICAL SCREWS. (FROUDE).

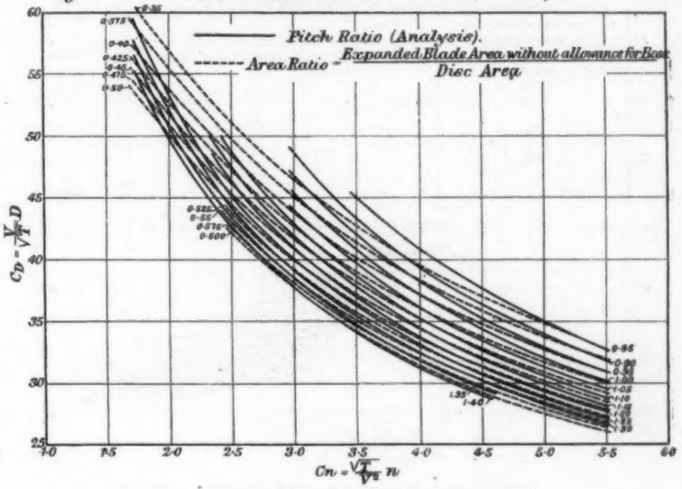


Fig.3. EFFICIENCY & SLIP RATIO. FOUR BLADED ELLIPTICAL SCREWS. (FROUDE).

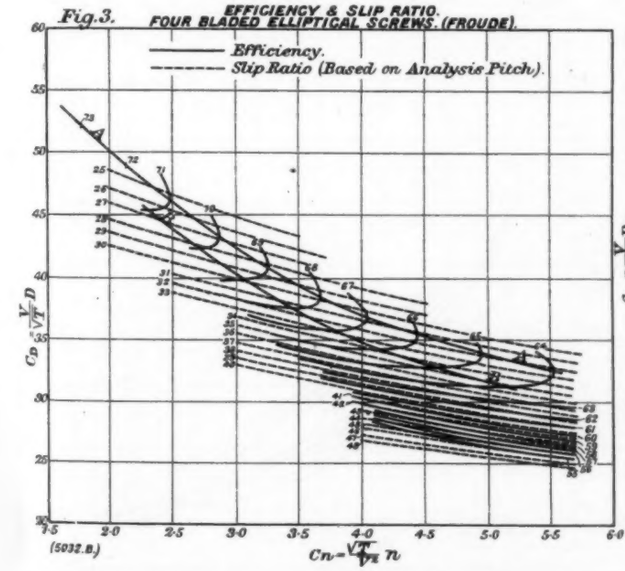
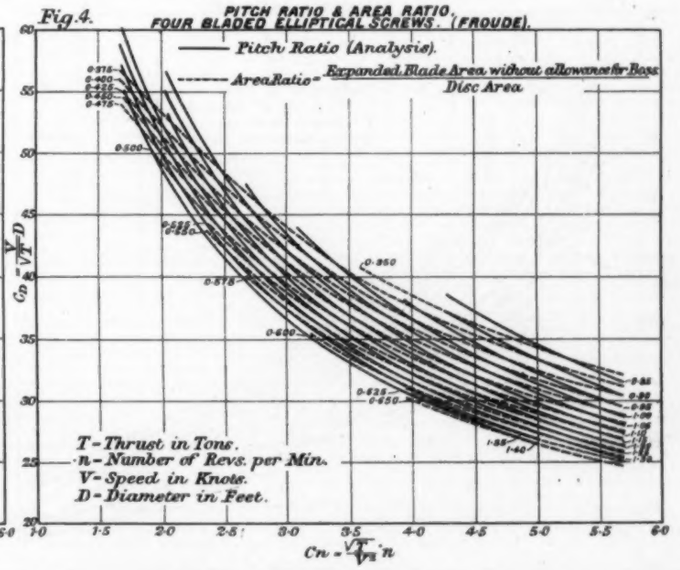


Fig.4. PITCH RATIO & AREA RATIO. FOUR BLADED ELLIPTICAL SCREWS. (FROUDE).


Pitch Ratio (Analysis).
Area Ratio = Expanded Blade Area without allowance for Boss / Disc Area
T - Thrust in Tons.
n - Number of Revs. per Min.
V - Speed in Knots.
D - Diameter in Feet.

a slight difference in efficiency values. If we take notice of the considerable difference of conditions of these two sets of experiments, for instance, the type of model propellers tried, the apparatus employed, and methods of experiments, &c., the agreement seems quite satisfactory.

The curves A A in Figs. 1, 3, 6, 7, and 8 are the loci of points at which the straight lines C_n = constant touch the contour lines, and therefore they determine the diameter and the efficiency for any assigned value for n; similarly the curves B B are the loci of points at which the straight lines C_D = constant touch the contour lines, and they determine the revolutions and the efficiency for any given value of the diameter.

A few conclusions which are brought out from these charts may be mentioned.

1. The efficiency is high at a small number of revolutions associated with large diameter, pitch ratio, and area ratio, and falls off gradually as the revolutions increase, diameter, pitch ratio, and area ratio also becoming smaller.

It will be inferred from the form of the curves that we can attain a greater efficiency than those shown in the charts by adopting a small value for C_n and a large one for C_D. It might be possible to get such a high efficiency, but it requires a heavy, slow-running engine and a large propeller, which will be prohibitive in a practical case. On the contrary, as there is a general tendency in recent days to adopt high revolutions for propellers, in virtue of the extended use of turbine engines, it will often be found that C_n is so great that it lies outside the field which is covered by the contour lines, and in these cases the difficult problem of cavitation usually takes place. It is a well-known fact that a model screw does not cavitate in tank experiments, while a full-sized one does in similar conditions. If we can construct an efficiency chart with respect to full-sized propellers, there may exist considerable differences between this and the charts shown in the paper. Even in this extreme case it is practicable, by careful analysis of trial results, to calculate the corrections, and by their application we can infer the most favourable number of revolutions for the turbine and propeller and determine the corresponding diameter, pitch ratio, area ratio and efficiency. These charts suggest to us that a screw propeller is an exceedingly successful apparatus for driving a ship of moderate speed when coupled with an engine of a moderate number of revolutions, but that some other means of ship propulsion should be looked for to meet the ever-growing tendency to higher speeds for ship and engine in these days.

2. Any particular combination of pitch ratio and area ratio occurs only once in each chart, and the efficiency shown in the charts corresponding to the combination is a little lower than the maximum efficiency of the propeller characterised by the combination, and the slip is greater than that of the maximum efficiency.

3. Fig. 5 is constructed by superposing Fig. 3 on Fig. 4. It will be found that the contour lines intersect at the curve D D. Above this line a three-bladed propeller gives better efficiency than a four-bladed one, while below it a four-bladed one is superior. It is frequently required to keep the diameter of a propeller within certain limits,

Fig. 5. COMPARISON OF THREE BLADED SCREW & FOUR BLADED SCREW.

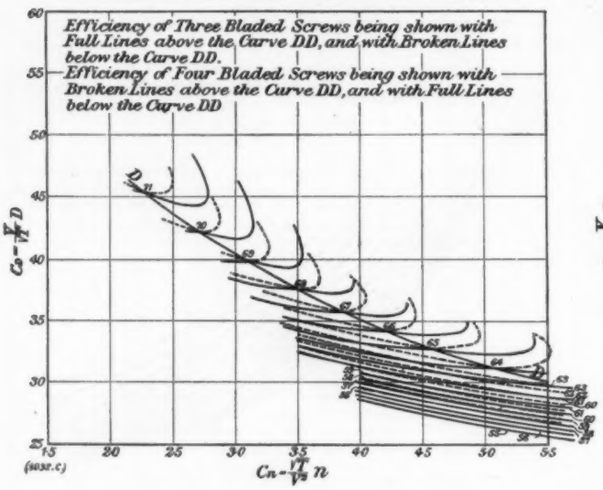

Efficiency of Three Bladed Screws being shown with Full Lines above the Curve DD, and with Broken Lines below the Curve DD.
Efficiency of Four Bladed Screws being shown with Broken Lines above the Curve DD, and with Full Lines below the Curve DD
(6032.c)

Fig. 6. EFFICIENCY OF THREE BLADED SCREWS (TAYLOR) THICKNESS RATIO = 0·04

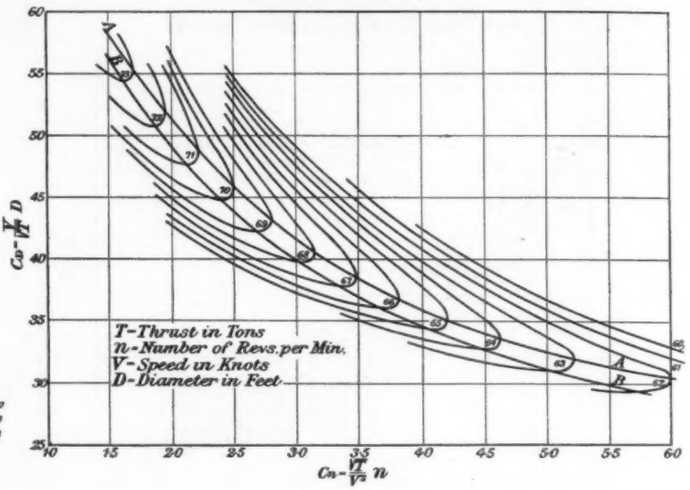


Fig. 7. EFFICIENCY OF THREE BLADED SCREWS (TAYLOR). THICKNESS RATIO-0·06.

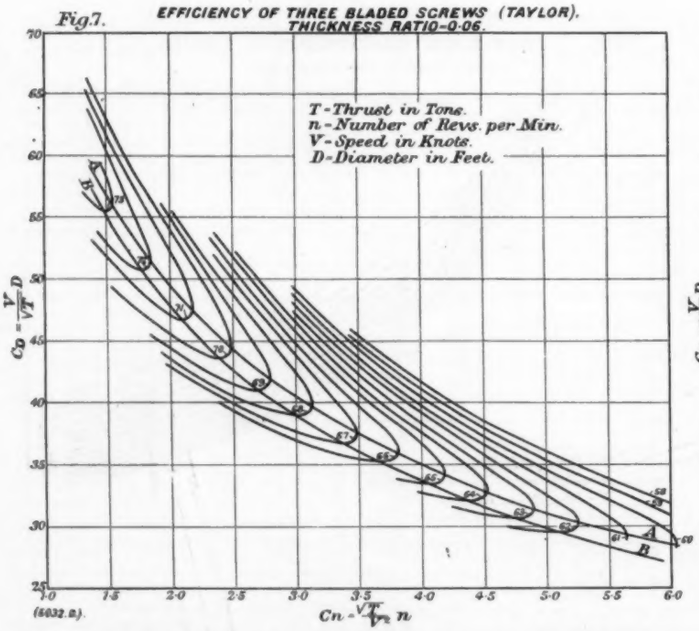
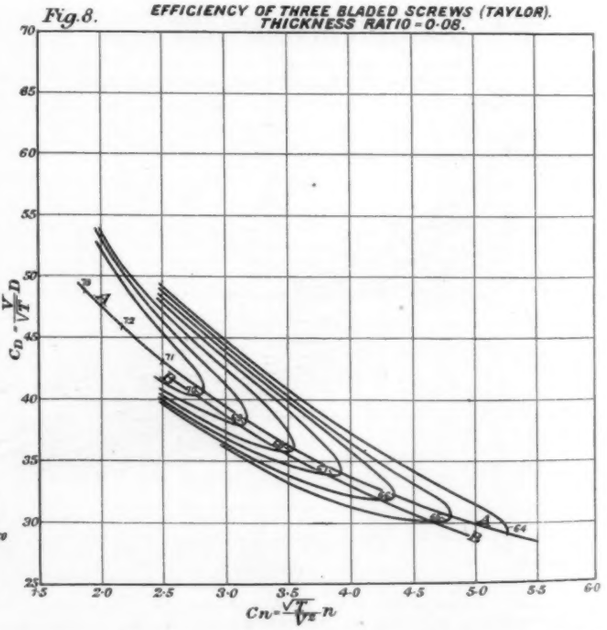


Fig. 8. EFFICIENCY OF THREE BLADED SCREWS (TAYLOR). THICKNESS RATIO = 0·08.

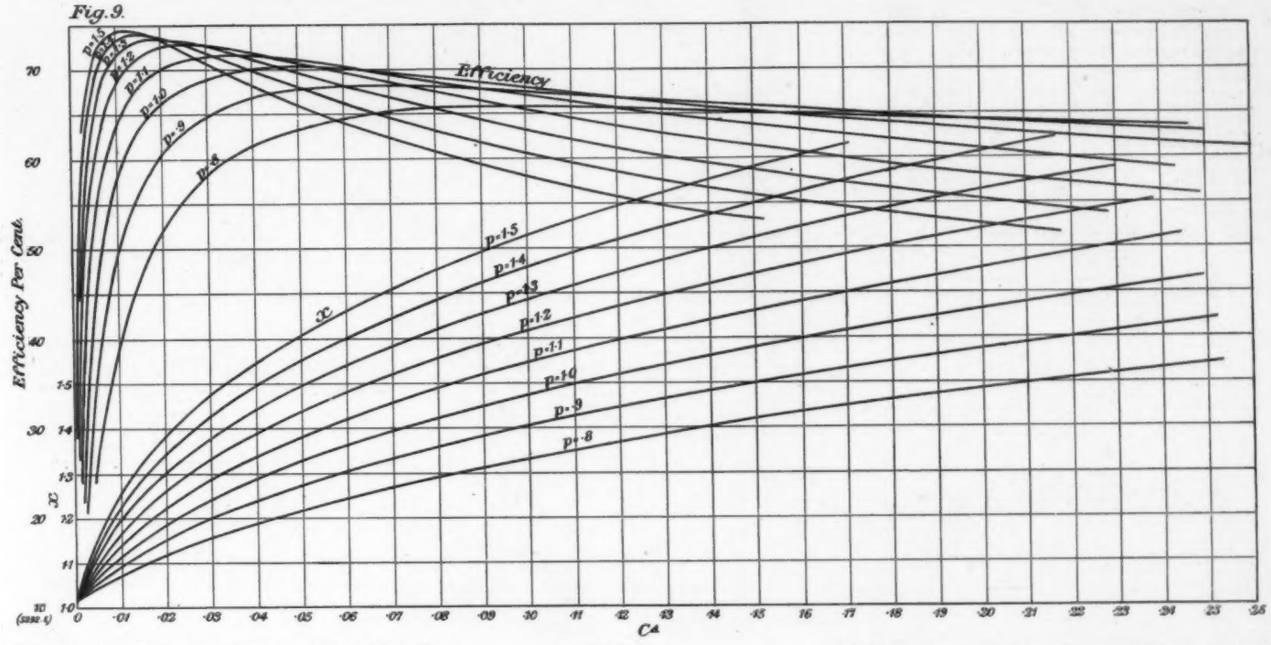


It is obvious in designing a propeller that it is desirable to determine the diameter and revolutions so as to locate C_n and C_D as near to the curves A A or B B as possible if the efficiency of the propeller only is to be taken into account. But in an actual case where a propeller works in a ship's wake the problem is not so simple. A propeller which is less efficient, when the propeller alone is considered, may give a better performance when combined with a ship than a more efficient one. It is out of the scope of the present paper to investigate the interaction of propeller and hull. It must, however, be noted that though the propeller efficiency is quite different from the propulsive efficiency, yet it is by no means a useless attempt to study the nature of the propeller action in open water. It will be of great value to calculate C_n and C_D for ships which have shown successful performances and to plot them on the charts. It will afford a satisfactory guide for a designer. The trial results of several ships have been analysed and show that the majority of C_n and C_D thus found lie between A A and B B.

especially in a merchant ship, where the immersion is variable. In this case the four-bladed propeller is distinctly preferable. The reason why a two-bladed propeller is not adopted, except in small craft, is quite evident. There are many opinions about the comparative merits of the three-bladed and the four-bladed propellers enuncinated by various authorities. Summarising their opinions, it may be said that the three-bladed propeller has not only better efficiency than the four-bladed one, but it should be lighter and cheaper; that a four-bladed propeller is recommended only in cases where the greater portion of each blade is above the surface of the water during the upper half of its revolution, as in the case of a cargo steamer without sufficient cargo, especially in rough water, and that in these conditions four-bladed screws will run more smoothly. Captain Dyson has pointed out in his "Screw Propeller" that in the case where the diameter is to be reduced below a certain limit the four-bladed screw will give better propulsive efficiency than the three-bladed screw. That is exactly the point which Fig. 5

AN ANALYSIS OF MODEL SCREW PROPELLER EXPERIMENTS.

Fig. 9.

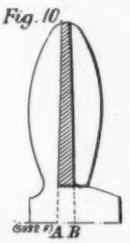


brings out. At a glance we can determine which of them, the three-bladed or the four-bladed, is to be preferred, while it requires somewhat lengthy calculation if one follows Captain Dyson's method.

—	Froude.	Taylor.
Number ..	36 in total, comprising 12 three-blade, elliptical 12 three-blade, wide tip 12 four-blade, elliptical	120, all three-blade, elliptical.
Diameter ..	9.6 in...	16 in.
Nominal pitch ratio	0.8, 1.0, 1.2, 1.4 ..	0.6, 0.8, 1.0, 1.2, 1.5, 2.0.
Area ratio ..	0.287, 0.395, 0.503 for three-blade, elliptical	0.229, 0.306, 0.382, 0.458, 0.535.
Expanded area / Disc area	0.437, 0.584, 0.730 for three-blade, wide tip 0.383, 0.527, 0.671 for four-blade, elliptical	
Thickness ratio = A B / Dia.	0.03	0.1033 0.0774 for screws of 0.0516 0.229 area 0.0258 ratio. 0.0894 0.0672 for screws of 0.0448 0.306 area 0.0225 ratio. 0.0800 0.0600 for screws of 0.0400 0.382 area 0.0200 ratio. 0.0730 0.0544 for screws of 0.0363 0.458 area 0.0181 ratio. 0.0676 0.0507 for screws of 0.0338 0.535 area 0.0169 ratio.
Diameter of boss	0.91 in.	3.125 in.
Immersion ..	0.64 ft. or 0.8 D ..	16 in. or 1 D.
Speed of advance	300 ft. per min. ..	5 knots or 506.67 ft. per min.

4. Figs. 6, 7 and 8 give us valuable information about the effect of the blade thickness on the action of a propeller. It is generally accepted that the thinner the blade the more efficient a screw will be. This statement may be accurate in a similar sense as a three-bladed screw is more efficient than a four-bladed screw. It appears that there exists some limiting value of thickness corresponding to the given values of C_t and C_D which gives maximum efficiency. To make the blade thinner beyond this limit seems quite useless. The thickness ratios in these charts are rather too large, and it was attempted to construct a chart for screws of thickness ratio 0.02, but the attempt failed because there is no maximum in the efficiency curve shown in Fig. 9 within the range of area ratio covered by the model screws. Even in constructing these charts it was often necessary to make use of the method of extrapolation, and, moreover, since there have been many difficulties in fairing curves passing through the points which were calculated by experimental data, they cannot by any means be accurate.

Fig. 10.



In preparing these charts it is intended to express the most complicated problems of screw propellers in the simplest form by keeping the number of variables as small as possible and assuming that our choice of the pitch ratio and the area ratio is quite free. Since all the omitted variables have little, if any, effect on the action of a screw propeller, and, furthermore, as the last assumption need not be strictly adhered to, because it is apparent from Fig. 9 that any slight deviation of the pitch ratio and the area ratio from those corresponding to the maximum efficiency does not produce any material difference from the maximum efficiency, these charts can practically be applied for a wider range of conditions than that specified in the course of constructing the charts.

THE ELECTRIC STEEL FURNACE IN THE UNITED STATES.—According to *The Iron Age*, the United States have taken the lead in electric furnace development, after a very slow start in which they seemed to be lagging behind some of the European countries. In the United States there is no less than 150,000 kva. in operation, or just being installed. The annual tonnage capacity of the furnaces using this current is estimated to be about 1,250,000 gross tons of ingots and castings. It represents an output about eight times as great as the crucible-steel production, and one-eighth that of Bessemer production. These two processes are not declining, but are more or less stationary, with wide annual fluctuations.

RUSSO-BRITISH NEWS BUREAU, LIMITED.—The Russo-British News Bureau, Limited, has been formed mainly to deal with Russian affairs and to promote mutual commercial relations between Great Britain and the Allies and the Russian Empire. At present politics cover nine-tenths of the news cabled from the average newspaper correspondent, the lack of commercial intelligence from Russia being painfully obvious. The present political excitement, it may be confidently hoped is only a passing phase, while the commercial development of the country is bound to become of increasing importance in the immediate future. It is the aim of the Russo-British News Bureau, Limited, to supply the deficiency in commercial and financial information which at present exists. Correspondents are stationed at Petrograd, Moscow, Odessa, Tiflis, Ekaterinburg, Samara, Kharkoff, Baku, Omsk, Kiev, Vladivostock and other important centres. The offices of the Bureau are in Gresham House, Old Broad-street, E.C. 2.

COMMERCIAL ABSORPTION OF EX-NAVAL AND MILITARY MEN.—There has just been issued by The Fleet, Limited, 11, Henrietta-street, Covent-garden, London, W.C. 2, at 2d. net, a brochure on this subject, written by Mr. Lionel Yexley. It deals with a problem of vast and vital importance, not only to the men of the forces, but also to the nation. Mr. Yexley contends for the establishment of a labour exchange inside every naval and military depot throughout the kingdom, the function of which would be to handle and replace in civil life time-expired men as they leave the services. He admits that the labour exchanges can do much, but such depot labour exchanges would form a necessary bridge between the fighting service and industry. Immediately pending the termination of a man's period of service he should be returned to his depot, and put in touch with the exchanges, where he should be treated in exactly the same way as the ordinary labour exchange treats the ordinary workmen looking for a job. In the majority of cases a man's requirements would no doubt be met in a few days; during the interval he would be employed in the ordinary work of his depot. As soon as a situation was secured he would be handed his discharge and a railway pass to the city of his employment. The subject is worthy of consideration.

THE LATE CAPTAIN WILLIAM BEARDMORE STEWART, R.F.A.—We regret to find the name of Captain William Beardmore Stewart, R.F.A., in the official list of officers killed, published on Monday last, as there is thus ended a most promising career in engineering. Thirty-two years of age, he was a son of the late Mr. Duncan Stewart, engineer, of Glasgow, and a nephew of Sir William Beardmore, Bart. After his education at Kelvinside, Glasgow, and Eastbourne, he served his apprenticeship in his uncle's firm. He passed through all the departments, gaining a wide experience of shipbuilding and engineering work. When the firm decided upon the construction of new works at Dalmuir his services were of great value, and he took a leading part in the carrying on of the work, the success of the extensions being largely due to his efforts. For nearly a year after the outbreak of the war his natural impulse to join the forces was restrained because of the obvious advantages of his services to the firm in connection with the building of warships and the manufacture of other munitions of war. In July, 1915, however, he joined the Royal Field Artillery, and had been at the front since August, 1916. Letters received from himself and from his superior officers show that he was a keen soldier, bringing the same qualities to bear on his work at the front as on the work he carried on at home. He was recently mentioned in dispatches. The General of his division writes:—"Your son was killed by a shell at about 8 o'clock yesterday evening; his battery was being shelled and he was hit by a piece of shell and died at once. He was doing glorious work at the time, encouraging and looking after his men. The Army has lost a soldier whose services were invaluable to me. As a soldier I can repeat only what I told you, he was one of those who always do their best, and his best was indeed worth having."

"ENGINEERING" ILLUSTRATED PATENT RECORD.

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The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

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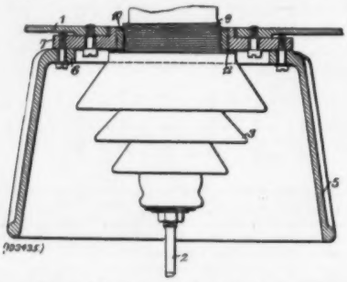
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

ELECTRICAL APPARATUS.

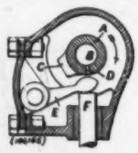
103,435. C. Vernier, Gosforth, Newcastle-on-Tyne, and British Insulated and Helsby Cables, Limited, Prescot. Junction or Terminal Boxes. (1 *Fig.*) July 18, 1916.—In connection with the insulators of electrical conductors of high potential electricity supply systems, and metal boxes or apparatus from which such conductors are led, and such insulators are protected by or disposed within shields or bells, the electrical factor of safety is raised by the application and use of a shield or bell of non-conducting material. 1 represents a part of a metal box from which a conductor 2 is led, it being passed through and surrounded and protected on the outside by a suitable downwardly inclined annular ribbed porcelain insulator 3 of the usual kind. The shield or bell of non-conducting material is marked 5, and has on its upper part an inwardly-extending flange 6; and to this



flange, on the outside, there is fastened a ring 7 of material of a suitable kind—say, cast-iron—which comes next to the metal box 1, to which it is secured; and between the inner edge of this ring 7 and the externally threaded portion 9 of the conductor insulator 3 there is introduced a tubular metal neck-ring 10, internally and externally threaded, the external thread meshing with the internal thread of the ring 7, and the internal thread meshing with the external thread 9 of the porcelain insulator. This ring 10 is cemented to the porcelain insulator 3; and between the upper shoulder of the insulator and the bottom of the neck-ring 10, and a part of the underside of the ring 7, a washer 12 is introduced, and pressed against the parts 7 and 10 by screwing up the insulator and these rings 7 and 9. (*Sealed.*)

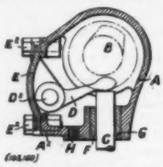
GAS ENGINES, PRODUCERS, HOLDERS, &c.

103,165. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Camshaft Lubrication. (1 *Fig.*) January 18, 1916.—According to this invention, oil fed to the interior of the hollow crankshaft is caused to issue through a number of holes, one of which lies in the plane of each cam. The hole is made through what might be termed the back of the cam, that is to say, some part which is not on the swell of the cam. The camshaft A is hollow, lubricant being supplied along the interior B. At the back of each cam C is formed a radial oil passage D, so that a continuous stream of oil is thrown out in the plane of the cam, lubricating the rocker E



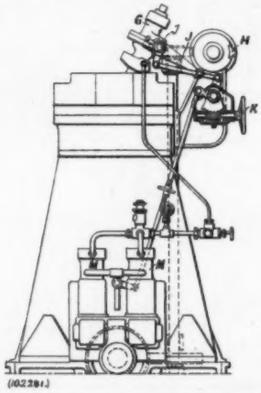
at both ends and the tappet F and its guide. If the hole D were made upon the operative portion of the cam it would tend slightly to weaken a part which is under stress, and, further, the hole would be closed by the tappet once every revolution. By making the hole at the back of the cam a continuous stream of oil is thrown out rapidly, lubricating those parts in this plane, such as the tappet, rocker or the like. Thus the oil supplied to the interior of the camshaft, in addition to lubricating the camshaft bearings in a known manner, is caused to be thrown on all the valve-actuating parts without necessitating the retention of a large quantity of oil in the casing. (*Sealed.*)

103,160. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Camshaft Casings. January 18, 1916.—According to this invention, the lower part of the camshaft casing is specially shaped to form a sump in which the oil collects, and the tappet guide, or the boss carrying this, projects above the wall of the sump. Below the top of the tappet guide or its boss is an overflow or drain outlet. The casing A is, as usual, provided with bearings for carrying the camshaft, the axis of which is shown at B. The cams on this shaft actuate tappets, one of which is indicated at C, and between each tappet and its cam is a rocker or valve lever D, which is employed to reduce the side thrust on the tappet. In the present construction each rocker, or each pair of rockers, D, is pivoted at D^2 to a plate E which closes a large aperture in the side of the casing. It will be clear that by unscrewing the screws E^2 the plate E and the rocker or rockers carried thereby can be withdrawn, disclosing the interior of the casing. In the bottom of the casing is formed a boss F, which projects above the bottom wall A^2, and this boss forms or carries the tappet guide or bush G. In the bottom wall A^2 is formed an outlet H, and to this may be attached a drain pipe of any suitable nature. Thus it will be clear that oil leaking into the casing will be drained away through the outlet H before it can reach up to the height of the tappet



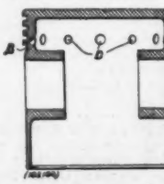
boss G, and in this way leakage down the tappet guides or their equivalent is prevented. If desired, a plate, such as E, may be provided at each side of the casing, thus making access to the interior still more easy. (*Sealed.*)

102,281. Vickers, Limited, Westminster, and J. McKechnie, Barrow-in-Furness. Internal Combustion Engines. (2 *Figs.*) January 20, 1916.—This invention relates to internal combustion engines of the type in which liquid fuel is injected into the working cylinder by means of a pump. According to this invention, the fuel is delivered by a pump M giving constant fuel pressure (by the aid, for example, of an adjustable relief valve) and the power of the engine is controlled by varying the period of opening of the injection valve G by an adjustable lever J operated by a cam H, the shape of which is so related to the path given to the end of the lever by the adjustment that for all adjustments and consequent variations in engine power the valve is timed to open at the correct point at which injection should take place. Independent timing means are therefore dispensed with, the cam being formed to give proper timing for the operation of the valve for all variations in the period of opening. In the construction preferred the control of the injection valve G is effected by a valve lever J on an eccentrically mounted pivot *j* which varies the clearance between the lever and the cam H and at the same time displaces the cam roller over the circumference of the cam in the desired direction to produce, with the cam, the proper timing of the valve



opening in conjunction with the variation in the duration of the opening which determines the power of the engine. The adjustment of the valve-lever cam H is preferably effected by lever and link connections to a control wheel K, which may act through a worm and worm segment. Connections may also pass from the same control to the suction of the fuel pump or pumps M, so that the output of the pump is simultaneously regulated, for example, by varying the closing of the suction valve. The pump is of a larger capacity than is required by the engine, and surplus fuel is discharged through the adjustable relief valve, which is set to give the injection pressure. The control of the suction of the pump allows, however, the output of the pump to be regulated as the power of the engine is varied. Excess fuel is always delivered by the pump, so that the pressure to which the relief valve is adjusted is maintained, but the excess over that required by the engine is kept approximately constant, thus assisting the relief valve to maintain a steady pressure. This connection to the fuel pump is particularly desirable for constant-speed engines, for example, those driving dynamos in which the surplus to be passed by the relief valve would otherwise be greatly increased while running at light loads. (*Sealed.*)

103,164. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Pistons. (1 *Fig.*) January 18, 1916.—This invention has for its object to provide means applicable to the pistons of internal combustion engines for preventing oil passing the piston rings and entering the combustion chamber. It is common practice to provide one or more grooves in the skirt of the piston in which the oil collects, and from which it passes through into the interior of the piston by means of a number of small holes. It is the object of the present invention to improve the efficiency of arrangements of this kind, and if necessary to improve the lubrication of the lower part of



the piston. According to this invention, the section of the groove B employed is roughly triangular, with the apex downward, and in the corner of the groove are made upwardly-inclined passages D communicating with the interior of the piston. Thus as the piston ascends oil in the groove is encouraged to pass downwards and lubricate the skirt of the piston, but as the piston descends it is prevented from travelling upwards past the groove, owing to the shape of the latter. The oil caught in the groove is, owing to its inertia, and the direction of the passages, caused to travel through on to the interior of the piston and to fall down inside the crank chamber. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

103,155. H. S. Hele-Shaw, Westminster, and F. W. H. Shepherd and Compayne, Limited, Hammersmith. Planing Machines. (5 *Figs.*) January 14, 1916.—This invention relates to the driving and control gear of hydraulic planing machines of that character where the table or moving part is driven by means of a continuously driven stroke pump whose volume and direction of delivery is controlled by the table or moving part of the machine. 1 designates a variable stroke pump connected by means of a suitable pipe system with rams 2 and 3, which are directly connected to the table or moving part 4 of the planing machine. The stroke-controlling ring of the pump is pivotally connected to a link 7 which, in turn, is pivotally connected to a second link 8 pivoted to a fixed lug 9. A connecting rod 10 connects this link mechanism to a trip lever 11. A lever 14 carries the inertia weight 15, and an adjustable link 17 is pivoted at one end to the inertia weight lever 14 and at its other end to the link 7. The link mechanism is supported by a suspension rod 20, which is pivotally hung. As is well known, a variable stroke pump, whatever its form, has a controlling device which, when arranged on one side of a neutral position, ensures delivery in one direction, and when this controlling device is moved to the other side of the neutral position the pump delivers in the other direction, and what was the suction side of the pump becomes the delivery side, and *vice versa*, while

Fig. 1.

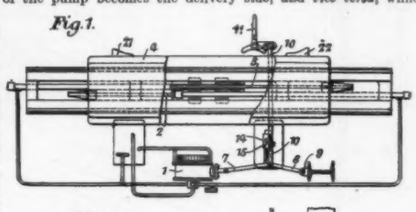
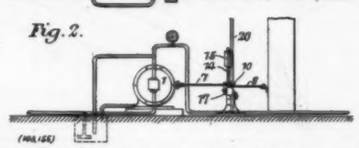


Fig. 2.



when this controlling device is in neutral position there is no delivery at all, although the pump is continuously running. With the inertia weight thrown over to one side the links 7 and 8, which together form a toggle, are thrown over in one direction and move the stroke-controlling ring in one direction. Liquid under pressure is thus caused to operate one of the rams 2 or 3, and the table 4 is thus moved in one direction. Upon the moving table cams 21 and 22 are provided. Assuming the table to be moving in the direction from left to right, the cam 21 comes into contact with the trip lever 11 and turns the lever; this movement of the trip lever is transmitted to the links 7 and 8, and by reason of the link connection 17 the inertia weight lever 14 is moved sufficiently to carry the inertia weight from the one side over the centre line when such weight falls to the other side, and the force exerted by this inertia weight in its fall operates through the links 7 and 8 to move the stroke-controlling ring of the pump to the other side of the central or neutral position, whereupon the pump at once reverses, with the result that the direction of movement of the table 4 is also reversed, and this reverse movement of the table continues until the other cam 22 actuates the trip lever 11 in the other direction and in exactly similar fashion causes the inertia weight to be thrown back again to its original position, and so on. (*Sealed.*)

PUMPS.

103,357. H. A. Humphrey, Westminster, and W. J. Rusdell, Wolverhampton. Valves. (11 *Figs.*) January 31, 1916.—The common form of flap valve is attached to its seating by a hinge or hinges, and often springs are used to close the valves. This invention relates to an improvement in valves whereby the functions of the hinge and of the closing spring are combined by connecting together valve and seating or fixed support by means of one or more coiled springs so arranged that the valve tends to be closed by virtue of the flexure of the spring or springs in a direction more or less normal to the axis of the coils. The valve-seating is shown at 1, which in this instance is part of the main valve box. The valve is made partly of metal, but the underneath surface is coated with a soft material such as rubber. In order that a number of valves may be arranged so that the outer edges form a polygon, the valves have two parallel and two inclined edges as shown in Fig. 2. The valve as shown is supported

Fig. 2

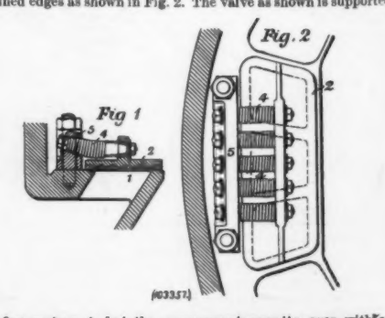


Fig 1

by five springs 4, but the arrangement permits, even with an existing valve, of various numbers of springs being used, in this instance from two up to five. Each spring has two conical ends, fitting respectively into conical holes in projecting lugs on part 2 of the valve and in bar 5 fixed to the valve seat. Conical-headed bolts secure the springs in the said holes. The springs may be wound with the coils touching, and with or without initial tension; or the springs may be open, according to the purpose for which the valve is to be used. In Fig. 1 the valve is closed, and the spring has been deflected from the straight free shape, so that the spring exerts pressure against the valve to keep it tight. If a piece of solid matter should get between the valve and its seat, when the valve should be closed, the springs allow the valve to accommodate itself temporarily to the obstruction until the latter passes, and then the valve will once more come to an even seat. (*Sealed.*)